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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.S., and E. S. GREW, M.A.

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"Summer Plumage."

By W. P. PYCRAFT.

THE fact that many of our native birds, with the return of spring, undergo a more or less complete transformation in their coloration, some even developing accessories in the shape of frills and tufts of feathers worn only for a few weeks, is a matter of common knowledge. At one time, indeed, among those who found delight in forming collections of British birds only specimens killed at the season when in their full splendour were deemed worthy of preservation. But collections so formed were made rather for the delight of the eyes than for any scientific purpose. Nowadays a new light has dawned upon us—a new standard has been raised. We see in these changes a new significance, and this we owe to Darwin's patient labours and profound insight. But my purpose now is not to comment on Darwin's work, but rather to review current notions in regard to this annual change commonly described as the assumption of the "summer" plumage.

The development of this plumage synchronizes with the advent of the breeding season, and seems to be an integral part thereof. Nevertheless it is associated with phenomena which have been generally overlooked.

The facts which have tended most to obscure and hinder a right interpretation are those which concern the striking change of livery which takes place in certain Limicoline birds, such as the Knot, Golden and Grey Plover, and the Ruff, for example, wherein the dress worn during the greater part of the year is exchanged during the early spring for one of a totally different character. In the Knot the discarded dress is of Quaker-like sobriety—grey above, white below—in the new garment red is the dominant hue, the upper parts present a mixture of black, chestnut, and white, while the whole of the under parts, save the abdomen and under tail coverts, glow with a bright chestnut. Grey and white similarly characterizes what we will call the every-day dress of the Grey and Golden Plovers and of the Dunlin. But in the spring the last named assumes a beautifully variegated mantle of black and chestnut, while over the breast there spreads a great black shield of inky black. The Grey Plover undergoes a no less striking change, the upper parts being exquisitely chequered with spots and bars of black and white set off by the velvety black of the sides of the head, the front and the sides of the neck and the breast. The Golden Plover, by way of contrast, in its summer dress has the upper parts spangled with golden yellow and black, the under parts are, similarly, jet black, but the general effect of this livery is still further heightened by a broad band of white, which extends from the forehead backward over the eyes, down the sides of the neck, and along the upper border of the flanks. As the summer draws to a close the whole of the black area is replaced by white and the black spots of the upper surface are smaller, so that the dominant hue is golden—hence the name. Immature specimens of the Grey Plover, it is significant to note, so closely resemble the adult Golden Plover in its non-breeding dress that the readiest way of distinguishing the one from the other is to examine the hind toe, which in the Golden Plover is reduced to a mere vestige; furthermore, in the Grey Plover the axillary feathers are black instead of white. But of this more must be said later.

Now in these changes of livery so far referred to both sexes participate, though, be it noted, the females are less brilliantly coloured. In the Ruff, on the other hand, though both sexes don what we may call a nuptial dress, that of the male differs in the most striking fashion from that of the female. Briefly, this contrast is due to the development of a huge frill or ruff of feathers surrounding the head, and large "ear-tufts"; but besides these the feathers around the beak are shed and replaced by little warty outgrowths of brightly coloured skin. To add to the marvel of it all no two males are ever coloured alike. The frill may be barred, or vermiculated, or whole coloured, and in hue may be white, black, buff, brown, chocolate, or an admixture of all, and a similar, though less noticeable, variability marks the rest of the plumage.

We have now passed in rapid review a striking series of liveries—black and white, black and red, black and gold, and multi-coloured—assumed with the advent of spring, and doffed before the end of summer. What facts may be derived therefrom?

To begin with, the resplendent livery is generally known among ornithologists as the "breeding" or "summer" plumage in contrast with the dress worn during the rest of the year and known as the "winter" plumage. But we are gradually beginning to recognise the fact that these distinctions express only half-truths, that much more lies behind them. Hence it is now becoming the custom to call the resplendent livery the "nuptial" dress, since it is so commonly associated with the period of reproduction. It would seem indeed that this intensification of pigmentation, and the frequent association therewith of exuberant growths, such as frills and tufts of feathers, is brought about by some stimulating essences emanating from the sexual glands when they awaken to activity. For these subtle "essences" the name "Hormones" has been coined; and thereon we propose to speak on another occasion.

Whatever may be the cause of the transformations so far briefly surveyed, it is to be noted that this summer or nuptial plumage is the beginning of all resplendent plumage. In other words, the "nuptial" dress in a large number of species has gradually replaced the "winter" plumage. And the process by which this change has come about may, I think, be followed in birds like the Ducks, and in the game birds.

Let us take the case of the Ducks, using the Mallard

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as an example. The female of this species, as everybody knows, is clad in sombre shades of brown, while her mate wears a very handsome livery. But it is by no means universally known that this livery is exchanged during the early part of summer for a dress hardly distinguishable from that of his mate, a change which Waterton described as going into "eclipse," emerging therefrom at the approach of autumn. Now this dress is commonly regarded as a specially interpolated plumage to serve as a "protective" dress, a mantle of invisibility during the critical period of moulting the quills. For Ducks, like some other birds, shed their quills not in pairs, but all together, and thus, for a space, they are flightless, and therefore helpless in escaping from their enemies. The dull-hued female garb then enables the drake, like the sitting hen, to escape the prying eyes of prowling carnivores. So soon as the new quills have developed the characteristic male livery is reassumed.

The protective character of this eclipse dress no one disputes, but the origin thereof is other than that generally supposed. In other words it answers to the "winter" dress of birds like the Plovers already discussed. In surveying this pageant of nuptial plumages it will be found that some species tend to inaugurate the change earlier, and to retain it longer than others, thereby, of necessity, lessening the duration of the "winter" or post-nuptial dress. In the Mallard the "nuptial" dress is assumed at the autumn moult, while the "winter" dress is worn only during the summer months! In the game-birds there is evidence that a similar state of things once obtained, for in some the "winter" dress still makes its appearance though now reduced to very scanty proportions, since only sufficient is developed to clothe the head and neck. The Jungle Fowl, the Black Cock, and the Grey Partridge are illustrations of this fact.

The last traces of this "winter" dress being eliminated so that the some time "nuptial" plumage becomes the only livery, as for examples, say, in the Pheasant, Blackbird, and Crossbill—to select illustrations at random—the next stage in the evolution of resplendent plumage takes place when the female dons a similar livery to that of her lord. In such cases the "winter" plumage is represented only in the immature birds, as in the case of some accipitres—the Starling and the Robin, to go no further. The Crossbill affords an illustration of "nuptial" plumages in the making, for the male acquires his bright red livery only by degrees; being, roughly, first green, then yellow, then red. His mate never passes beyond the green and yellow stage. The young birds, as they leave the nest, present a yet earlier, more ancient phase of plumage, being ash brown in colour and heavily striated on the under parts.

The Kingfishers are an instructive group in this connection. In our common Kingfisher (*Alcedo ispidia*) male, female, and young are all coloured alike, though the young lack the brilliance of the fully adult bird. But in many exotic species in which the adults of both sexes are brilliantly coloured, the young birds wear a totally distinct livery of dun brown hues, indicating an earlier, ancestral plumage. But in this particular group, happily, there exist species which are dull coloured throughout life, albeit exhibiting proofs of an incipient resplendent plumage—*e.g.*, the Laughing Jackass (*Dacelo gigas*).

This interesting history of the sequences of plumage and the evolution of resplendent liveries might well have been backed up by more striking examples, but I have purposely selected my illustrations from among our native birds, for the sake of those who may be tempted to follow this matter up during the breeding season in which we have now entered.

The Conservation of Mass.

By ALFRED W. PORTER.

(*Continued from last month, p. 88*).

THE CHARGE OF AN ATOM OF ELECTRICITY.

WHEN a cloud is formed by the sudden expansion of moist, ionised air, each drop falls under the action of gravity. For such particles Sir G. Stokes showed many years ago that the velocity of fall must rapidly become constant. This constancy arises, of course, as soon as the frictional forces (which increase with the velocity) become equal to the pull of gravity. For a spherical particle the limiting velocity is given by the formula:

$$\text{Applied force} = 6\pi\mu v r$$

where μ is the viscosity of the gas
v is the limiting velocity
r is the radius of the spherical particle.

The applied force in the case of a sphere falling in a gas of negligible density compared with its own is the weight of the particle itself; that is, it is

$$\frac{4}{3}\pi \quad g r^3 \text{ where } \rho \text{ is its own density.}$$

Hence

$$v = \frac{2 g \rho r^2}{9\mu}$$

In the earlier experiments use was made of the fact that the limiting velocity is much the same for all the particles in the cloud owing to the approximate uniformity in their size. It was sufficient, therefore, to observe the rate of change in level of the cloud's upper surface, and thence to calculate an average value for r; the total mass of deposited vapour can be calculated from the amount of expansion and thence the number of cloud particles was determined. A further determination of the total charge on a similar cloud enabled the average charge on each particle to be determined. This method is very unsatisfactory, however, because underlying it there is the tacit assumption that each particle contains a single unitary charge. Experiments have been made quite recently by Professor R. A. Millikan which do not suffer from this defect. Professor Millikan deals instead with *individual* particles of an expansion cloud; the motion of these is observed as they move across the field of view of a short focus observing telescope. Not only this, but it was found possible by superposing an upward electrical field to bring any one charged particle to temporary rest. The idea of employing an electrical field to modify the velocity due to gravity had previously been used by Professor H. A. Wilson, but Millikan's use of it constitutes a very distinct advance. Let us see what information can be obtained in this way.

If gravity alone is operating the force acting upon the particle is the weight alone, mg. But the particle is charged, and will therefore experience a force in an electrical field. The charge it possesses can only be an integral multiple of the unitary charge, say, ne. The force that this experiences in an electrical field X is Xne. Arrange so that this force acts vertically upwards so as to oppose gravity, and the downward velocity will be reduced, or even reversed. If the particle can be kept sensibly at rest for some little time the two forces must exactly be counterbalancing each other; or in terms of an equation—

$$Xne = mg;$$

whence

$$ne = \frac{mg}{X}$$

The electrical field is then destroyed, and the particle falls under the action of gravity. Its velocity v is determined, and thence the radius is calculated. For since

$$v = \frac{2 g \rho r^2}{9 \mu} \text{ we have } r^2 = \frac{9 \mu v}{2 \rho g}$$

and we get —

$$ne = \frac{mg}{X} = \frac{\frac{4}{3} \pi r^3 \rho g}{X}$$

$$= \frac{\frac{4}{3} \pi \rho g}{X} \times \left[\frac{9 \mu v}{2 \rho g}\right]^{\frac{3}{2}}$$

The viscosity of air saturated with water vapour is shown to be—

$$\mu = \cdot 0001904 \text{ at } 26^\circ \text{ C.}$$

Putting this value into the equation and putting ρ (the density of water = 1, Professor Millikan writes:—

$$ne = 3 \cdot 422 \times 10^{-9} \times \frac{g}{X} \; v^{\frac{3}{2}}.$$

The electrical field is created by producing a difference of potential of 100 or 200 volts between two parallel horizontal brass plates. The procedure of the experiment is simply to form a cloud and throw in the field immediately afterwards. The drops which have charges of the same sign as that of the upper plate, or too weak charges of the opposite sign, rapidly fall; while those which are charged with too many multiples of sign opposite to that of the upper plate are jerked up against gravity to this plate. The result is that after the lapse of seven or eight seconds the field of view has become quite clear except for a relatively small number of drops which have just the right ratio of charge to mass to remain suspended by the electric field. These are those upon which observations of the velocity of fall are made after the removal of the field. The values of ne found in various cases (in some of which alcohol was used instead of water) are these:—

$$13 \cdot 85 \times 10^{-10} \text{ or } 3 \times 4 \cdot 59 \times 10^{-10}$$
$$18 \cdot 25 \times 10^{-10} \text{ or } 4 \times 4 \cdot 56 \times 10^{-10}$$
$$9 \cdot 284 \times 10^{-10} \text{ or } 2 \times 4 \cdot 64 \times 10^{-10}$$
$$24 \cdot 14 \times 10^{-10} \text{ or } 5 \times 4 \cdot 83 \times 10^{-10}$$
$$9 \cdot 742 \times 10^{-10} \text{ or } 2 \times 4 \cdot 87 \times 10^{-10}$$
$$28 \cdot 16 \times 10^{-10} \text{ or } 6 \times 4 \cdot 69 \times 10^{-10}$$

It will be seen that the assumption that the total charge on any drop should be a simple multiple of a unitary charge is fully justified by these results. The simple mean value deducible for the unitary charge is $4 \cdot 70 \times 10^{-10}$; or if allowance is made for the fact that some of the observations are more reliable than others it becomes

$$e = 4 \cdot 65 \times 10^{-10} \text{ electrostatic units,}$$
$$\text{or } 15 \cdot 5 \times 10^{-20} \text{ coulombs.}$$

When Clerk Maxwell spoke of molecules of electricity he apparently "builded better than he knew," for he thought he was devising a provisional hypothesis afterwards to be cast aside. The value of the charge of this molecule of electricity has become one of the most fundamental units of Nature.

Although this is not a direct determination of the charge on a cathode particle or on an electrolytic ion, we may very scientifically inquire what the consequences will be of assuming that it would be the same unitary charge that would be determined in these other cases if only a measurement were possible.

Take first the case of electrolysis. The charge associated electrolytically with one gram of hydrogen is 96,340 coulombs. Compare this with Millikan's value for e and we deduce that the mass of a hydrogen atom (which by supposition carries the charge e) must be about $1 \cdot 6 \times 10^{-24}$ grams. To put the result in another way, we recall that a cubic centimetre of hydrogen under standard conditions has a mass of ·00009 gram. Hence the number per cubic centimetre of molecules (each consisting of two atoms) will be $\frac{\cdot 00009}{1 \cdot 6 \times 2 \times 10^{-24}}$ or about 3×10^{19}. But this number is of the same order as that commonly accepted for the number of molecules of any gas per cubic centimetre under standard conditions; and thus the assumption that in electrolysis we are dealing with the same unitary charge is justified. If now we make the same assumption with respect to the cathode stream and regard it as also consisting of particles, each carrying the unitary charge, the value deduced for the mass of each particle must be about the seventeen-hundredth part of that of a hydrogen atom.

Whence does this mass arise? We are writing of electricity and at the same time are attributing to it the most fundamental property of matter! Is electricity, after all, only another variety of matter whose atoms are much finer than those of the ordinary chemical elements? or is it wrong to consider the possession of inertia as the characteristic of matter? In dealing with these questions a clear distinction must be drawn between mass (or inertia) and weight (or gravitational pull). It has been shown that the stream possesses *inertia;* it has never been shown that it possesses *weight.* May it not be that it is the possession of the latter quality which may most usefully be considered as the peculiarity of matter, and that inertia may arise in many ways? The answer to this is necessarily a question of definition; and if we have hitherto regarded inertia as the inalienable property of matter alone, we must either withdraw now from that position in the interests of a science whose business it is to differentiate as well as to gather into groups, or else regard electicity as a form of matter.

Whatever the ultimate answer may be, one thing is sure, that the inertia of the particles of the cathode stream can be explained by the aid of electromagnetic conceptions alone. We shall deal with this explanation next month.

The Brent Valley Bird Sanctuary.

SIRS,—The members of the Brent Valley Bird Sanctuary Committee have continually received the kind assistance of the Press in their work, and the notices given to the last leaflet issued by the Selborne Society on the methods adopted of attracting wild birds will be fresh in the minds of your readers.

I have therefore no hesitation in making an appeal now that the nesting season will soon be in full swing for renewals of, and additions to, the contributions that have enabled us to maintain the Sanctuary in the past.

We shall be pleased to enter the name of any subscriber of eighteenpence against a nesting-box in our numbered list and report as to the result obtained, while in the case of those who contribute five shillings and upwards we shall be glad to make arrangements for a visit to the Sanctuary.

Yours, etc.,
(MRS.) HILDA E. WEBB.
(Honorary Secretary of the Brent Valley and Bird Sanctuary Committee).

Odstock, Hanwell, W.,
March 12, 1910.

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Engonasin.

By WM. PARKINSON, M.A.

THE question of the origin of the constellation figures is a muddy pool which I have no wish to stir up. It is a subject which has given rise to much word-warfare. Those who have attempted to penetrate the mystery surrounding the birth of the strange forms may be divided into two camps: Those who maintain that the conformation of the star groups had little or nothing to do with the determination of the figures by which they are now known, and those, on the other hand, who contend that these figures were directly suggested by some fancied resemblance in the contours of the groups to objects familiar in Nature, history, or legend. That the latter theory is the true one in many cases there can be no question. It is obvious, for instance, that the Plough

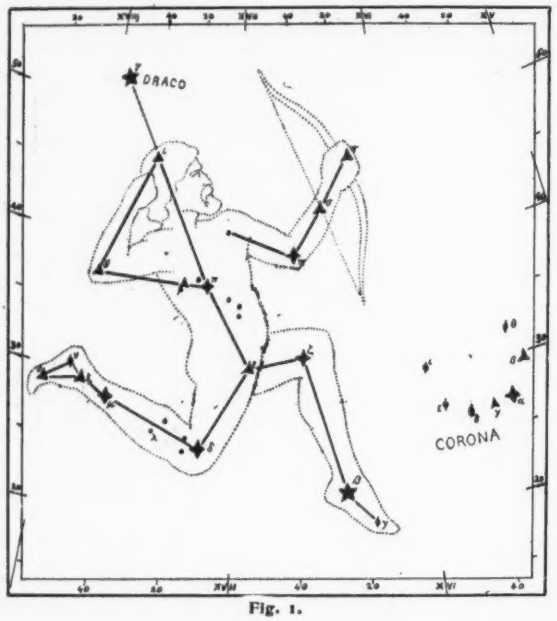

Fig. 1.

gained its name in that way; so also the Northern Crown, the Cross, and many others. But there is one famous constellation figure which, up till now, has presented special difficulties, and which I hope to show belongs distinctly to the second of the groups above described—to that, namely, in which a fancied shape suggested the choice of figure. This is the constellation Hercules.

At first glance, if we look at the distribution of the stars in that constellation, there is nothing to suggest the figure of the hero in the conventional form we find depicted on celestial globes and charts; but I shall endeavour to show, nevertheless, that in the grouping of the stars themselves there can be found the origin of the figure and the explanation of the attitudes in which he is usually represented.

Hercules, that majestic sign which fills so vast a portion of our northern skies in summer, was not originally so called; his name until comparatively recent times was Engonasin, that is to say, the Kneeler; and on almost all celestial globes and charts he is depicted as a kneeling man. We may find him drawing a bow, or flourishing a mighty club, or holding up the lion's skin, or wrestling with the many-headed Hydra, or even, as on the Farnese globe, "with empty hands outspread"; but in each case, no matter "to what toil he is attached," he is always the man kneeling upon one knee—Engonasin.

Now I remember as a boy being much struck by the remarkable resemblance of a certain star-group to a human foot and leg, bent in the position they would assume in kneeling. Having perceived that form I very naturally sought to complete the figure of the man to whom the leg belonged, and to do so no great effort of imagination was required. A long and well-marked row of brilliant stars at once presented itself to form the head and body; another star came in most opportunely for the upraised knee, and, just where they were wanted, two other stars supplied the planted foot.

Now it is a strong point in favour of my theory that all this was observed by a boy knowing little of the constellation names, and absolutely nothing of their history.

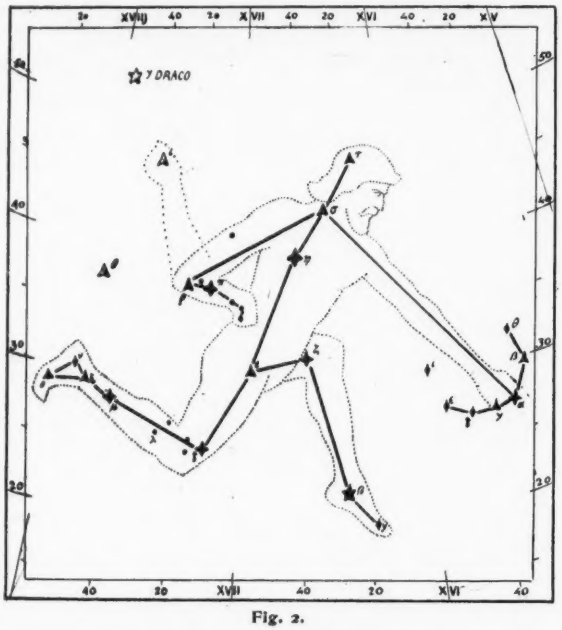

Fig. 2.

If you will refer to the drawing (Fig. 1) you will see the kneeling leg that first attracted my attention formed by ϵ at the pelvis, δ at the knee, and ξ, ν, o at the foot, the shin and calf being well indicated by the bright star μ and several smaller ones. This I may call the clue; when once you have found it, it is a simple matter to construct the body by the conspicuous row of stars ϵ-π ι, the eye being guided also by γ Draconis, though it is not necessary to include this star in the actual figure. Then for the left or upraised knee comes ζ, and for the ankle β, with γ to suggest the toe.

One can imagine that an ancient Babylonian or Assyrian would see in such a posture the attitude of an archer kneeling, an attitude familiar to his eyes in the sculptured monuments, or in his own experience of war, and he would need no great power of fancy to complete the figure, supplying the upper limbs by joining π through ρ with θ for the right arm, and η σ τ for the left. Mark how well the figure of the hero tallies with the star points named!

But now having found the Bowman, the bright semicircle of Corona Borealis catches the eye, and at once suggests a bow with Gemma (α Coronæ) for the shining

Arrow-head. But the bow is rather far away. This difficulty, however, is soon overcome, for a better adaptation of the stars that form the hero's body will now present itself, and enable us to construct a kneeling archer with his bow and arrow actually in hand. In my drawing (Fig. 2) I have shown this second step, but it will be seen that the original posture of the legs remains unchanged. τ-σ-η now make the head and body, and ρ and π with a group of smaller stars the bent right arm (σ ρ ι is perhaps better still), and by a slight stretch of the imagination, and a somewhat severer stretch of the hero's arm, we join the Archer and the Bow; σ with α Coronæ. When once the eye has detected this arrangement the figure becomes so obtrusive it is hard to understand its not being recognised, or how, once recognised, it can ever have been lost sight of. Yet it has been lost sight of for centuries and centuries. I have no doubt in

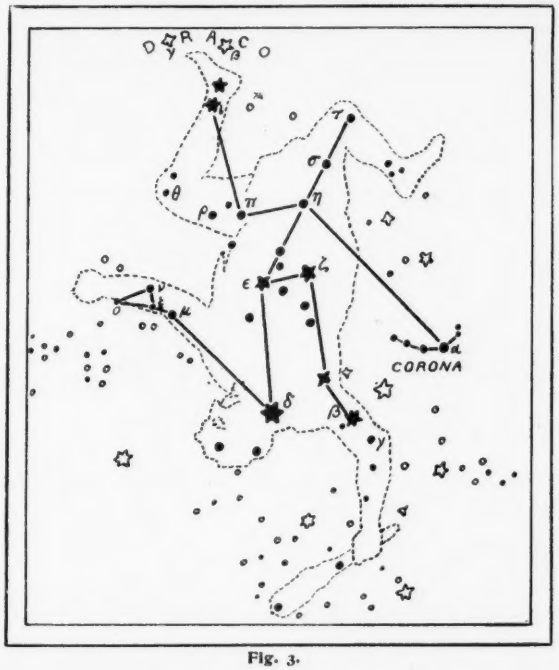

Fig. 3.

my mind that the first star-gazers saw it as I have described, and probably went through the same progressive stages that I did; and what more natural, if this were so, than that the name of Kneeler should have suggested itself?—a name inexplicable otherwise, and certainly not indicated by the grouping of the stars as they are at present distributed in the figure Hercules.

In the beginning no special personage would have been ascribed to the configuration. Says Aratos in his Phainomena:

> . . . like a toiling man, revolves
> A form. Of it can no one clearly speak
> Nor to what toil he is attached; but, simply
> Kneeler they call him.

The name arose spontaneously just as in the instances I gave of Plough (or Dipper), Crown, and Cross, and others; but later astronomers, though they have adopted not only the traditional name, but even the traditional attitude of the sign, have failed to see its very obvious outline in the stars.

Even if we go back to the remotest existing records we find that the origin, both of name and posture, has been already lost, and no observer (as far as I can ascertain) in modern times has rediscovered it. They all agree in placing the poor hero upside down, his head where his feet should be, his back presented to Corona Borealis. Now there is nothing in the distribution of the stars to warrant this inversion; there is very much in favour of placing him upon his feet and right way up. Proctor, in his "Myths and Marvels of Astronomy," very wisely remarks "that in imagining figures of certain objects in the heavens, the early observers would not be apt to picture these objects in unusual positions."

Yet Aratos—and it is certain that he took his facts

Fig. 4.—From Blunt's "Beauty of the Heavens."

Fig. 5.—From "Encyclopædia Britannica," Edin. 1797.

Fig. 6.—From Italian Globe, 1502, Cluny Museum.

from still earlier writers—thus describes the constellation of the Kneeler:—

> . . . his right foot
> Is planted on the twisting Serpent's head,
> And here that Crown which Dionysos placed,
> Of Ariadné dead a glorious sign,
> Revolves behind the weary toiler's shape.

And when describing the position of Lyra he says:

> Fronting the unknown form he set it down—

meaning, by the unknown form, Hercules, or the Kneeler.

In the later Hipparcho-Ptolemaic star-list the position of the figure is the same; the star α represents the head—that is to say, the picture is exactly an inversion of the actual image formed by the configuration of the stars.

J. A. Proctor, in a little book of "Star Lessons," says: "Hercules is not now [in the month of May] in the proper attitude of a kneeling person. For the star α marks the place of his head, so that his feet are flourishing upwards. In fact, Hercules never is seen in our latitudes as a kneeling man. When he is at a convenient height for observation in the west he is supine, while now in the east he is nearly prone, as one who has fallen almost headlong and face downwards."

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But if you will stand with your back to the north and look at the figure as I have drawn it (Figs. 1, 2, 8, 9) you will see the hero not prone, nor on his head, nor in any other incongruous position, but planted firmly with left foot thrust out, and right knee resting on a base line, which is the natural and reasonable one, for it is parallel to the equator, and is common to the adjacent figure Boötes.

When I describe Hercules as upside down, I hope I shall not be misunderstood. Proctor, while admitting that "position must have counted for something in determining the association between a star group and a known object," adds: "Now the constellations north of the Equator assume so many and such various positions that this special consideration does not apply very forcibly to them." But it is not the inversion of the figure Hercules, regarded generally, that I am disputing, for his position is always shifting, but it is his placement relative to his neighbours and in the phantasmagoria of the circumpolar signs. [See fig. 8.]

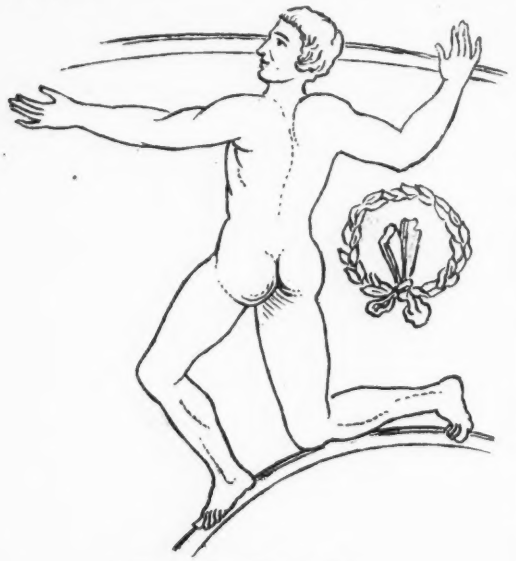

Fig. 7.—From Farnese Globe.

Professor Robert Brown, who has gone so deeply into the question of the origin of the constellations, and for whose opinions I have the most profound respect, has apparently not observed the Hercules, or rather Kneeler, who exists entire in every detail, ready made to hand; and adopting the traditional topsy-turvy hero, whose outline conforms to no disposition of the stars, founds several of his theories as to the other constellations on this inverted image. For instance on p. 132, Vol. I., Primitive Constellations, he explains that Sagitta was the symbol chosen for a certain group of stars, not at haphazard, but precisely because the ancients wished to show therein the Arrow, shot from the Kneeler's bow among the Birds. This may be so, but only on the supposition that Sagitta was a late invention as compared to the Kneeler, dating from a period when the original form of the latter had ceased to be perceived. Sagitta, I am aware, is one of the oldest constellations, but the Kneeler is probably as old as man himself. The star-depicted Kneeler could never have shot the arrow from his bow, for it lies behind him—on the ground, so to speak; and alas! for the three Demon Birds I have to put them out of the picture also; but perhaps it may be some compensation to observe that the head of the serpent which Ophiuchus holds comes near enough for Hercules to grasp and strangle, if so minded; and Hercules strangling the Hydra is a frequent version of this constellation sign.

There is much to be said for Herr Georg Knaack's contention that the original names were rather general than special. Professor R. Brown in Appendix IV., to his translation of the Phainomena of Aratus, says: "Herr Knaack believes that these names were at first wider, and afterwards became narrowed through a special mythic story being tacked on to a particular constellation by the arbitrary fancy of some poet," and instances Engonasin as afterwards specialised as Hêraklês, Ornis as Kyknos, Kentauros as Cheirôn, and Potamos as Eridanos.

Professor Brown asks "What proof does he give, or can any one give, that Kneeler, Bird, and Centaur were (in any language) the original names of these constellations?"

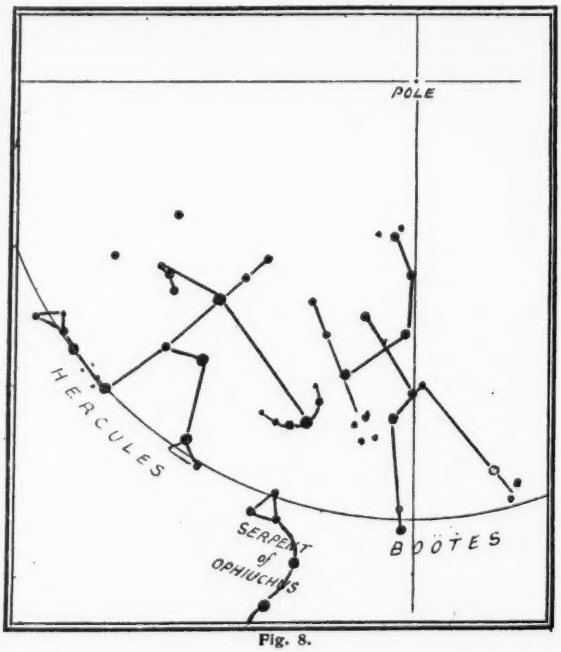

Fig. 8.

But looking at the figure of the Kneeler in the stars themselves no proof is needed. When one sees an obvious kneeling man there, one's natural impulse is to call him Kneeler—the general before the special appellation.

And a few lines further on Professor Brown says: "Let the name of a constellation be borrowed and brought far from the place where it was first known and used, introduced to foreign nations and translated into other tongues, and then, naturally, nay almost necessarily, great part or the whole of its pristine history is lost; the special original hero is forgotten, but the fancied shape of the constellation preserves a name—the Kneeler." Now this argument appears to me in this particular instance as much an inversion of the probable facts as is the traditional sign of Hercules itself. It is not the "special original hero" who has been forgotten; there was not one; it is the "fancied shape"—the kneeling figure itself that has been lost sight of, although it is true the constellation still preserves his memory in the name Engonasin.

Surely we need not take the tortuous road Professor Brown points out when we have so short and straight and obvious a one before us. Evolution works along the line of least resistance, and why not in this case? The

same process that obviously acted in the naming of Boötes and many other constellations doubtless was at work here. Yet, speaking of the sign Boötes, Professor Brown (Prim. Const., Vol. I., p. 282) says: "Let us reconstruct the figure by the aid of the star-list, and the process, which, of course, can be applied to any other of the primitive constellations of the Greeks, will serve to illustrate how a pre-existing idea was applied to particular stars. [Figs. 8, 9.]

Now this is precisely the reverse of what one would conclude from a study of Boötes, of many other constellations, and of Hercules especially, if my contention is right. Anyone regarding these constellations with a mind unprejudiced by theory would naturally conclude that as one star-group bore a marked resemblance to a kneeling man, another to a man declaiming (or with a staff in hand, if so your fancy guides you), the early observers would first dub them respectively Kneeler and Declaimer (or Herdsman) inevitably—from their attitudes. Yet Professor Brown says that "none of the numerous names by which the constellation has been known were arrived at merely by independent observation of the stars which it contains." How can he know? The names themselves point most distinctly otherwise. Here we have a constellation with the exact figure of a kneeling man, first known simply by the general name of Kneeler, and only in later times attributed to the special hero Hercules. The same has happened in the case of Boötes, Herdsman, or Declaimer. Yet Professor Brown insists that "the names are all connected with prior and external ideas, to which the natural configuration of these particular stars is made to accommodate itself"; almost as if the observer could manœuvre the stars about to suit his constellation figures. Yet here was I, a boy knowing nothing of these "external ideas," irresistibly reminded of a kneeling man in a constellation which I long afterwards discovered had been known for centuries as the Kneeler. Why should others, by a like "independent observation," not have seen and known him thus?

In the little chart (Fig. 8) are shown the principal stars that compose the Herdsman and his position relative to the restored Kneeler. For comparison I have given (Fig. 10) a reproduction of Boötes as the constellation is figured in a curious old popular text book entitled "Beauty of the Heavens," by C. F. Blunt, 1842. For the sign Hercules as rendered in the same volume see Fig. 3.

It is quite possible that later, when the constellation of the Kneeler became identified with the special hero Hercules, it was found convenient to invert the figure in order to involve and harmonise with it other groups, such as the Arrow and the Birds, which would help to illustrate the Herculean myth. Then, this inversion once established, no one thought more of the poor abandoned Kneeler.

I have a further reason for preferring my own rendering of the sign. If you look at a chart of the northern hemisphere you will see how well the hero takes his place in the great procession of Immortals around the Pole Star; the giant forms move in majestic order across the zenith, each on the same base line, each in just proportion to the others, and all in vertical position as regards the Pole and the Equator, as one would reasonably desire.

And there is yet another fact which argues in my favour. Professor Brown has proved beyond doubt that a vast proportion of ancient coin-types were of astronomical signification. In Fig. 11 I have given a rough sketch of a beautiful coin of Cyzicus which depicts Hercules on right knee with right arm raised and holding in his left hand a bow. Now the attitude of this figure tallies remarkably with that which I have drawn in Fig. 1, although my reconstruction was made before I knew of the existence of such a coin, and it is noteworthy that the figure faces to the right as in my outline.

On the well-known Florentine gem (Fig. 12) we have another rendering, very similar as regards the legs, but conforming rather to my second version (Fig. 2 and Fig. 9 *b*, *c*) in the action of the arms. And in the attitude familiar to us on ancient globes and charts (Figs. 4, 5, 6, 7), although the figure is inverted, if a tracing were taken and reversed, the head put where the feet now are, the outline would be found to correspond point by point with my Engonasin.

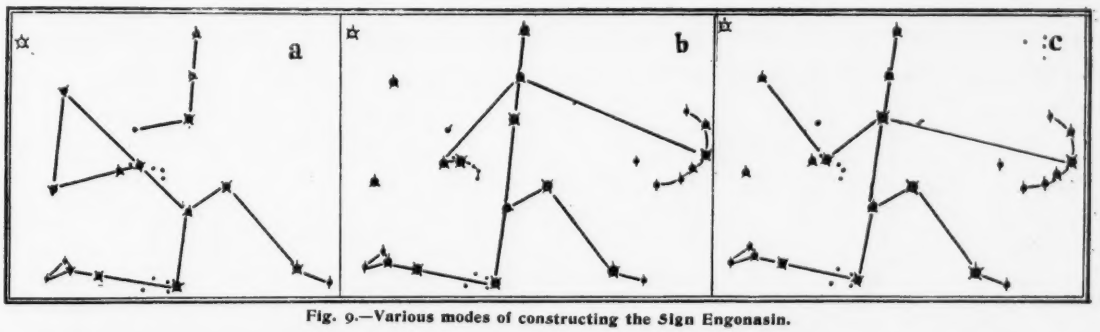

Fig. 9.—Various modes of constructing the Sign Engonasin.

What object could there have been in representing this personage as always kneeling, or in speaking of him simply as the Kneeler, unless some configuration of the stars first suggested the otherwise inexplicable attribute? The question appears to have exercised the minds of others before now. Aratos, in his poem quoted above, speaks of Hercules as "the unknown form," of which

> Can no one clearly speak,
> Nor to what toil he is attached; but, simply,
> Kneeler they call him.

He evidently is at a loss to account for the name which has no special applicability to Hercules in any of his characters, and in another verse he says:—

> He who is never far distant from the Lyre,
> Whoe'er this stranger of the heavenly forms
> May be.

Professor Robert Brown does not explain away the difficulty in the following note to the above: "Originally the Kneeling Izdubar, the great solar Euphratean hero, who in the grand strife of Kosmos against Chaos, overcomes Tiamat, the Dragon. The Kneeler was afterwards very properly called Hêraklês = Hercules, the corresponding personage in the Hellenic Pantheon."

And he remarks in another place: "This constellation

was evidently the subject of much curiosity; all tradition respecting the personage represented had been lost," and he quotes Manlius, "Nixa venit species genibus, sibi conscia causae."

But no personage had been lost to tradition, for the sufficient reason that no personage had existed; the figure was simply the Kneeler, until in later years it

Fig. 10.

Fig. 11.

was ascribed to Hercules or his prototypes in earlier classifications.

I think if any one will compare carefully the diagrams I give he will admit that if the case is not *vero* it is at least *ben trovato*—it is certainly a strange coincidence.

Compare the Kneeler in Fig. 1 with the following description of him by Aratos:

. . . . Labouring on his knees,
Like one who sinks he seems; from both his shoulders
His arms are raised; each stretching on its side
About a full arm's length.

In Fig. 3 I have given an illustration of the constellation figure in the position in which it is usually represented. The author, C. T. Blunt, from whose book I have taken it, has let his fancy play both in the positions and the magnitudes of the stars, and it was not an easy task to identify them.

Fig. 6 is a rough sketch from a beautiful bronze globe

Fig. 12.

Fig. 13.—From Al-sufi, Persian Astronomer, 10th Century. Described by Prof. J. E. Gore, F.R.A.S., in "Knowledge," Nov., 1907.

in the Cluny Museum, Paris, described as Italian work, 1502, where Hercules is a young man holding up the lion's skin, and is called Engonasis.

It is interesting to note that in every one of the representations the hero is kneeling on right knee, even when, as on the globes, he is supposed to be viewed from a point above the stars, instead of from the earth, as in the charts.

The actual figure of the Kneeler is much more obvious when the sky is not too clear than when his outline is confused by the host of minor stars.

A DEMONSTRATION of the use of electricity as an anæsthetic was recently made in Hartford, Conn., where a patient was thus anæsthetized while four frozen toes were removed from his foot. For the electrodes two zinc plates were used, one applied to the groin and the other to the ankle. During the operation the patient, who was blindfolded so that he would not witness the work of the surgeons, felt no pain and chatted and talked in a natural manner. When the operation was over he experienced no after effects.

The Application of the Telephoto Lens to Photomicrography.

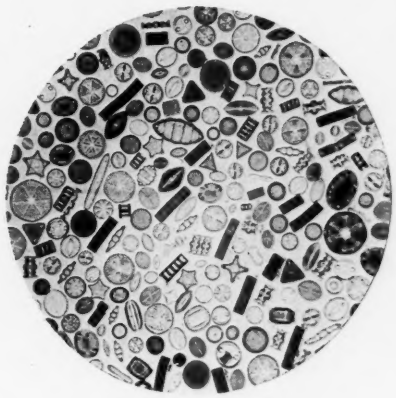

Fig. 1. × 37.

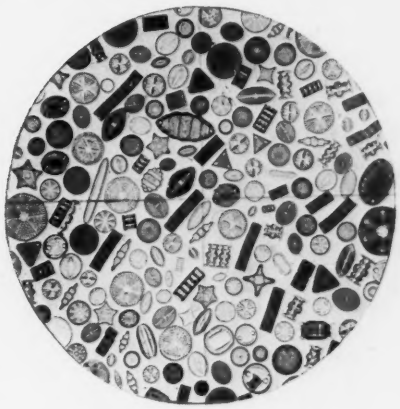

Fig. 2. × 45.

Fig. 4. × 205.

Fig. 5. × 200.

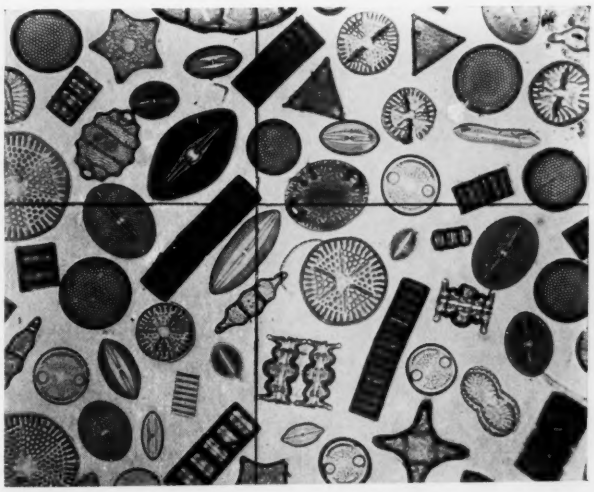

Fig. 3. × 130.

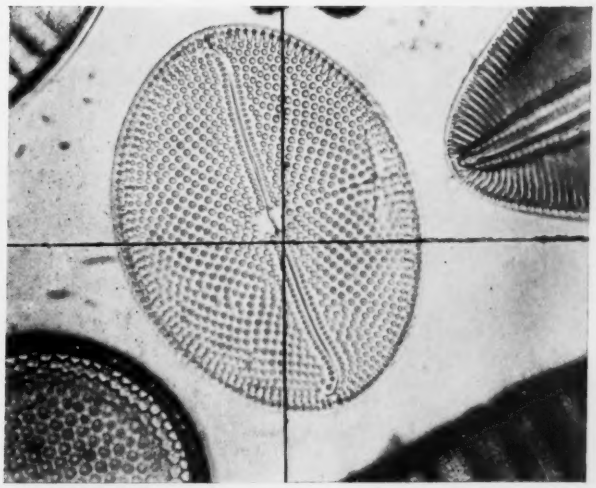

Fig. 6. × 610.

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The Fertilisation of a Green Orchid.

By G. W. Bulman, M.A., B.Sc.

Professor Plateau, of the University of Ghent, has for many years been engaged in a remarkable series of observations and experiments on the mutual relations of insects and flowers. As a result he has been forcibly led to the conclusion that the bright colours of the latter, making them conspicuous in contrast with the green foliage, *do not* play the important *rôle* in attracting the former usually attributed to them. He contends, in fact, that such colours are of no importance as regards the chances of obtaining insect fertilisation, and that the flowers would be as certainly fertilised if they did not possess them.

One of the many interesting arguments brought forward in favour of this view is that there are a large number of *green* and *greenish* flowers which are visited and fertilised by insects. In Part IV. of his researches, entitled *Comment les fleurs attirent les Insectes*, published in 1897, Professor Plateau gives a list of some 79 such species. These flowers, he points out, are as effectually fertilised by insects as those which are white, blue, red, or yellow. Hence, he continues, all these floral colorations might disappear without any consequent lessening of the fertility and reproductive powers of the plants.

Pursuing his investigations of such green and greenish flowers, Professor Plateau finds that his list of them is now almost doubled; and in a recent paper contributed to the Royal Botanical Society of Belgium he gives the result of his studies of the pollination of a familiar green orchid known in this country as the Tway-Blade (*Listera ovata*). In order more conveniently to study this plant and its insect guests, Professor Plateau has grown it in his garden and watched it carefully during four successive springs. Growing the plants in pots he was able to place the flowers in the most favourable position for their insect visitors, and for making his observations on them. The result of this four years' work is to confirm abundantly the great thesis that the brightly coloured corollas of flowers are of no significance as regards their chances of insect fertilisation, and that they might all be as green as their leaves without any loss in this respect. And further, in several interesting details, Professor Plateau has been able to correct and supplement the accounts given by earlier writers of the fertilisation of the Tway-Blade. This green orchid and its fertilisation has been a favourite subject with more than one well-known naturalist. C. K. Sprengel, of Spandau, whose work on insects and flowers formed the foundation of Darwin's well-known theory of the evolution of the latter by the *selective* action of the former, studied the Tway-Blade. Darwin, H. Müller, MacLeod, and Knuth, among others, have written on it. According to their accounts the fertilisation of the flower takes place as follows:—

The insect alights on the lower part of the lip, and begins to lick the honey which is contained chiefly in a furrow which runs down the centre of this part. Following this upwards it reaches a part of the flower known as the rostellum, where also is situated the anther with its pollen masses. As the insect, having sucked up the honey, raises its head to go, these pollen masses attach themselves to its head by the glands at the bases of their stalks. The insect flies off armed with these to another flower. Working it in the same way it finally brings the pollen masses into contact with the sticky surface of the stigma. Some grains adhere, and the flower is fertilised.

Familiar with these classical descriptions, which seem to imply that such is the usual manner and result of an insect's visit, Professor Plateau was greatly surprised at what he found to be the actual facts.

"Je fus stupéfait en constatant que, dans un très grand nombre de cas, les actes des animaux étaient tout différents."

He found that instead of always alighting on the lower part of the lip and walking up, they would attack the flower anyhow (*n'importe comment*), and go over it in *all directions*. In coming to a flower they would alight anywhere on it (*n'importe où*). If they alight often on the lip it is because the lip is the largest part of the flower, and not from any special design. Sometimes an insect begins to suck honey at the top of the lip, and works downwards. And it *often* happens that an insect leaves a flower without carrying off the pollen masses. Thus out of 152 insect visitors recorded by Professor Plateau only 13, or doubtfully 15, did so. And on one occasion he saw an ichneumon fly visit more than 20 flowers without carrying off the pollen masses from any of them. The comparative infrequency of the occurrence is further indicated by the fact that Professor Plateau, adding the cases recorded by other observers to his own, can only make a total of 45 cases in which it has been observed. Again, owing to the irregularity in their manner of visiting the flowers, the pollen masses sometimes adhere to other parts of the insects' bodies than the head, and so are useless for fertilisation. And it might naturally be expected that the insects would be embarrassed by these awkward appendages thus glued to their heads, and try to get rid of them. As a matter of fact they often do so successfully. Sprengel was perhaps the first to observe an ichneumon fly rid itself of the disagreeable excrescence bestowed on it by the flower. And Professor Plateau's observations fully confirm this interesting fact. There is no doubt that of the comparatively few insects which succeed in carrying off the pollen a large proportion manage to get rid of it before going to another flower. And it is strange that they do not *all do so*.

But let us suppose an insect armed with the pollen masses visits another flower in the orthodox way. There are on the spike flowers at all stages of maturity, and this particular one may be already fertilised, or, on the other hand, not yet ready for fertilisation. Again pollen is wasted. And Professor Plateau notes that the pollen masses are frequently shaken out by the wind, and in their native haunts by birds and small animals. In the case of the plants grown by Professor Plateau in his garden this loss of pollen masses without serving the purpose of fertilisation was indicated by the large number, conspicuous by their yellow colour, which he found each day lying on the green leaves:—

"Cette dispersion des pollinies sans effet fécondateur utile est si manifeste que j'en trouvais chaque jour gisant sur les larges feuilles de mes pieds de *Listera* où leur coloration jaune les rendait bien visibles."

Yet in spite of all this loss of pollen, Professor Plateau found that practically all his flowers bore seed. And he quotes on this point the similar experience of Darwin, who, on a spike which had 44 opened flowers with their pollen masses removed, found pollen, generally in great quantity, on all the stigmas which he examined. The great majority of the flowers of *Listera ovata* are doubtless fertilised:—

"Mes observations personelles ne laissent aucun doute sur la fécondation effective de la grande majorité des fleurs."

How, then, can this be reconciled with the undoubted fact, brought clearly into view by Professor Plateau's experiments, of the frequent loss of the pollen masses? The explanation lies in the *numerous* insect visits:—

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"En effet, le déchet en pollinies est compensé par le chiffre considérable de visites d'insectes pendant la période de floraison et par cette particularité qu'un même animal parcourt souvent la surface d'une série de fleurs successives."

Thus if even a restricted number of insects, having carried off the pollen masses, do not succeed in ridding themselves of the encumbrance, these by going over a large number of flowers will fertilise the greater number of the blossoms.

As regards the species of insects visiting and fertilising the Tway-Blade, it has generally been considered that they mostly belong to the family of ichneumon flies. Lord Avebury, in his "Insects and Wild Flowers," says, "This flower appears to be exclusively visited by ichneumons." But according to Professor Plateau's observations, out of 152 insect visitors 84 were flies (Diptera), and only 21 ichneumon flies (Hymenoptera). Of the remainder, 43 were other species of Hymenoptera, including bees, two Lepidoptera, and two beetles. Yet the most frequent fertilisers appear to be the ichneumonidae. For of the 13, or doubtfully 15, cases of the removal of the pollen masses seen by Professor Plateau, seven were by species of ichneumon flies. In five cases he observed them removed by flies, and claims to be the first to have seen this accomplished by any of the Diptera. The reason why the ichneumons, though much less numerous as visitors, more frequently carry off the pollen is due to the difference in the structure of the mouth in the Diptera. In the flies the proboscis is long enough to enable them to lick up the honey on the highest part of the lip without bringing their heads under the rostellum, and thus getting the pollen masses attached to them.

Thus we see that Professor Plateau's observations, while abundantly confirming his great thesis that bright colours in flowers do not play that important *rôle* in attracting insects usually assigned to them, also correct certain important details in previous accounts of the manner of fertilisation of the Tway-Blade.

A Belgian View of English Eoliths.

By W. G. CLARKE.

IT is probable that the finest collection of eolithic implements in Europe is that preserved at the Royal Museum of Natural History at Brussels, the curator of which, M. A. Rutot, was one of the foremost, as he has been one of the most persistent, advocates of the artificial character of the chipping on these rude relics of the handiwork of primitive man. As a voluminous writer on this and kindred branches of prehistoric archæology he has also rendered considerable service to European archæologists, more especially with regard to a proper classification of the various periods, by which alone it becomes possible to institute legitimate comparisons between the implements and implement-yielding beds of various countries. As a consequence, the views of "A. R."—which internal evidence shows is M. Rutot—on "La Préhistoire en Angleterre," as published in a booklet issued by the "Comptoir Ethnographique de Belgique" have considerable value for English archæologists.

The first article of what promises to be a valuable series deals with eoliths, and in the course of this M. Rutot says (his remarks being freely translated) that in consulting the principal works on the subject the impossibility of giving a satisfactory account of the prehistoric archæology of Great Britain, or even of that of England, is easily recognised, for in that country chronological classification remained, until recently, quite rudimentary. The only big work treating of prehistoric archæology is that of Sir John Evans, and it is a matter of surprise, when one considers the part that archæologist has taken in advancing knowledge of the amygdaloidal implements discovered by Boucher de Perthes in the Quaternary alluvium of the Somme Valley, and which were the handiwork of man, to think how, after this first effort, the ideas of classification and chronology have been entirely strange to him. It seems that Sir John Evans scarcely dared to indicate two great divisions in prehistoric archæology, the Paleolithic and Neolithic, and he never grasped the idea of classification, nor made a serious attempt to apply that of G. de Mortillet, which he was not, however, able to ignore. It is known, moreover, that Sir John never accepted eoliths.

In reality, England is a country of wonderful richness in prehistoric industries; implement-yielding strata and sites are numerous, and there are several remarkable collections of implements. This long period of obscurity happily tends to come to an end, and the trustees and curators of the British Museum have set an example by introducing in the collections on exhibition the rational chronological methods adopted in other countries. There is primarily one fact it is necessary not to lose sight of, and that is that Great Britain was only detached from the Continent at the end of the Quaternary period, or, rather, at the beginning of the modern period. During Tertiary times there was always a junction, and throughout the Quaternary period England has only been the direct continuation of the Franco-Belgian territory. These vast territories formed a whole, subject to the same biological and geological conditions. The only difference that existed was that two-thirds of England had been subject to the direct action of the Quaternary glaciations which did not affect the Franco-Belgian region. From this standpoint, England (with Scotland) may be divided into two parts, the northern comprising at least two-thirds of the country and subject to glaciations; the southern not having been so subject, and having also participated in the conditions which prevailed over the Continental area. The boundary between the two great divisions coincides approximately with the course of the Thames. Therefore, at least in the south of England, the course of events was the same as in France and Belgium, and on that account it is obvious that these regions had a common pre-history. The facts which prove it are these.

In England, nobody has yet discovered remains of primitive or eolithic industries in the Oligocene or Miocene, but it cannot be said that such finds will not some day be noted. Pre-history certainly begins with the Pliocene and probably with the Middle Pliocene. In reality the Lower Pliocene is coincident with a marine invasion, and the Kent plateau area could not be occupied by primitive tribes until the retreat of the sea. As the formation of the actual hill and valley system, that is to say, the excavation of the valleys, had begun with the Middle Pliocene, and the eoliths discovered on the chalk plateau were deposited there previously, it follows that the heights bordering the great ridge that remained from the uprising of the Weald were not habitable until the end of the Lower or Middle Pliocene. These primitive populations left on the surface of the plateau at a height of more than 150 metres above the sea-level remains of a purely eolithic industry, without modification or improvement, and this I have proposed to call "Kentien." A little later, the cutting of the valleys having been begun, a ridge was developed on the plateau

which then constituted a lower region, and there was deposited above the gravels of the Kentien industry a greenish alluvial clay, now altered and oxidised, which has been termed the "Red Clay." This development seems to have driven away the primitive tribes of the region, and the valleys continued to be scooped out until they attained a depth of from 30 to 50 metres above the actual level of the waters. On the gravel-covered banks arose settlements of new primitive families with a purely eolithic industry, the exact equivalent of those which occupied the valley of the Eure at Saint Prest.

These people, who saw the *Elephas meridionalis* and contemporary fauna, consequently existed during the Upper Pliocene, and now that the industry of St. Prest has been known for a long time, and has been called the "Saint-Prestien," it follows that the families who were established in the valleys of the South of England ought to be associated with it.

Primitive man with a purely eolithic industry consequently inhabited at least the South of England, and up to the present his existence has been proved in the Middle Pliocene (Kentien) and in the Upper Pliocene (Saint Prestien), from Alderbury, near Salisbury, from Dorset, and from the coast near Cromer. After the Upper Pliocene we enter into the Quaternary, and we know that with that epoch began the great glaciation, the most important of all, which enveloped England and Scotland north of the deep valley of the Thames where the immense front of the northern ice-cap was raised. That enormous mass of ice must have had an influence on the climate of the region around, and it is improbable that human families occupied the sides of the valleys into which was diverted the cold water flowing from the glaciers. There is consequently little chance of finding in England traces of the eolithic population which dwelt in France and Belgium by the sides of the streams whose valleys were only yet excavated to 30 metres above the actual level of the waters. These populations have received, as is well known, the name of Reutelien.

But at length when the bottoms of the valleys attained the level of the waters which flowed there, the retreat of the ice permitted some tribes to occupy the banks of the rivers and there to leave evidences of the purely eolithic Mafflien industry. Nevertheless the Mafliens scarcely had the opportunity to occupy the bottoms of the valleys for long, for the climate became milder, and the ice-cap dissolved rapidly, causing a formidable flood in all the watercourses. That flood reached a height of 60 to 65 metres and deposited in England, as in France and Belgium, the fluviatile deposits of the Lower Quaternary, well represented at Erith, to the east of London, by the green clayey gravels containing *Elephas antiquus* and *Corbicula fluminalis*. I have personally found Mafflien flints at Erith, among the broken flints at the base of the gravels containing *Elephas antiquus*, and resting on the Thanet Sand (Lower Eocene) or on the chalk.

The retreat of the glaciers towards the north becoming accentuated, the eolithic tribes returned to the valleys and settled on the surface of the moraine from the great glaciation, where they left relics of the Mesvinien industry. The Erith section has furnished me, from the top of the gravels containing *Elephas antiquus*, with some Mesvinien implements. In England, as in Belgium and France, the chief eolithic industries, Mafflien and Mesvinien, are found in the Quaternary gravels of the low valley-terraces, as at Ditton, for example.

M. Rutot's views on the classification of Paleolithic and Neolithic implements in Great Britain will doubtless be keenly anticipated and appreciated.

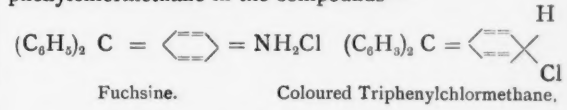
The Triphenylmethyl Problem.

By Herbert H. Hodgson, M.A. (Camb.), B.Sc. (Lond.), Ph.D. (Heidelberg).

Part III.

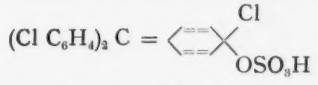
On the Quinone Structure in the Triphenylmethane Derivatives.

The double compounds of triphenylchlormethane with metallic chlorides, discovered by Norris and Sanders and more fully investigated by Kehrmann, have aroused the greatest interest on account of their yellow colour, *e.g.*, the amber coloured compound with aluminium chloride. As the cause of this colour Kehrmann has accepted an analogous quinonoid constitution to that of fuchsine for the Triphenylchlormethane in the compounds—



Fuchsine. Coloured Triphenylchlormethane.

Baeyer submitted the above hypothesis to an experimental test, in which he prepared such a coloured sulphate; in fact, instead of triphenylcarbinol he employed a tri-para-halogen substituted triphenylcarbinol. Under these circumstances in order that such a sulphate should possess a real quinonoid constitution, one of the chlorine atoms occupying the para position, and united as a quinol, must be easily capable of being split off.



By bringing together a chloroform solution of tri-para-chlor-triphenylcarbinol and less than the calculated quantity of concentrated sulphuric acid, and shaking the mixture well, Baeyer succeeded in preparing beautiful red coloured crystals of a sulphate. The mechanical separation of the crystals from the sulphuric acid presented great difficulties, chloral being the only solvent which did not decompose the salt. The composition of the salt corresponded to the formula—

$$C_{19}H_{12}Cl_3.\ SO_4H + H_2SO_4.$$

It is here worthy of mention that the sulphate of triphenylcarbinol could only be obtained as an uncrystallisable orange-coloured oil.

When the above acid sulphate of tri-para-chlortriphenylcarbinol and also the sulphate of tri-para-iodotriphenylcarbinol were brought into contact with silver acetate in a solution of glacial acetic and sulphuric acids, no trace of a silver haloid was found even after 24 hours standing. Both chlorine and iodine appear to split off very tardily, and Baeyer therefore was of opinion that this particular sulphate could not possess a quinonoid constitution.

Gomberg has recently conducted a similar series of experiments, and arrived at opposite conclusions to those of Baeyer. He employed a different method for preparing the coloured sulphate—viz., shaking a benzol solution of triphenylchlormethane with silver sulphate, whereby a layer of insoluble carbinolsulphate quickly formed over the benzol solution. In like manner, by shaking tri-para-chlortriphenylchlormethane with silver sulphate, Gomberg obtained a sulphate red in colour but differing from Baeyer's sulphate in that it contained equimolecular

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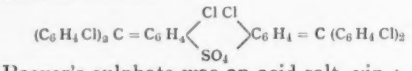
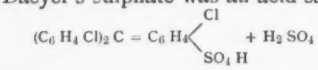
quantities of sulphuric acid. The salt was normal and possessed the formula—



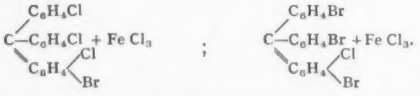
while Baeyer's sulphate was an acid salt, viz. :—



By shaking this normal salt for a long time with silver sulphate, Gomberg found an atom of chlorine to be split off, and accordingly concluded that the sulphate must possess a quinonoid constitution. According to Gomberg, this splitting off of halogen did not take place in Baeyer's experiment because an excess of sulphuric acid was present, which, by acting as a negative catalysator, hindered the reaction. The normal sulphate, which hitherto had not been isolated, was prepared as a pure substance by Gomberg through the action of silver sulphate on the carbinol chloride. In addition by hydrolysis of the red sulphate obtained from mono-para-bromtriphenylmethylchloride a yellow crystalline substance was formed, possessing a quinone odour, and thought by Gomberg to be diphenylquinomethane (Fuchsone). $(C_6H_5)_2C = C_6H_4 = O$. Baeyer, however, pointed out that diphenylquinomethane is without smell, and was of opinion that the experiment made by Gomberg, viz., the shaking with silver sulphate for a week, had caused a complete disruption of the molecule, and further that the quinone odour observed must be due to ordinary quinone. Baeyer regards the acid sulphate, which he himself isolated, as being the only well-defined sulphate.

Baeyer, and also Gomberg, have demonstrated the impossibility of splitting off halogen from the above sulphate by the agency of silver or silver salts. If, however, an insufficient amount of sulphuric acid is present, as obtains with the silver sulphate treatment, then the silver sulphate shatters the molecule, and in addition detaches the halogen belonging to the ring. Gomberg has expressed his intention of revising these experiments, and accordingly we must await his results before making any conclusions as to the constitution of these salts.

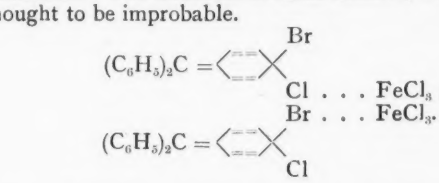
Baeyer believes that the following experiments have great weight in deciding as to the quinonoid structure of these coloured salts. The bromide of tri-para-chlortriphenylcarbinol, and also the chloride of tri-para-bromtriphenylcarbinol form coloured double salts with ferric chloride. If these are formulated according to the quinone theory, then the quinone parts of each substance must be identical—



If, however, both these double salts be decomposed by caustic soda, then in each case a carbinol is reformed, and since the quinol part containing chlorine and bromine must behave alike in both cases, it is to be expected that both will be immediately split off. The actual result of the experiment was, however, that the bromide of the tri-para-trichlor-derivative split off exclusively bromine, the chloride of the tri-para-brom-derivative exclusively chlorine, and therefore Baeyer believes he has clearly demonstrated that these coloured double salts are not quinonoid.

Baeyer next proceeded to discuss the objections which could be raised against his conclusions. The most important of these could be a circumstance in which the chlorine of the tri-para-bromtriphenylchlormethane unites with the iron chloride in the process of forming the double salt thereby causing a quinone rearrangement to take place—

In this event a different behaviour of the halogen atom possessing quinone nature would result, and Baeyer then brought into notice the possibility of the following case of Isomerism. The existence of these isomers, however, he thought to be improbable.

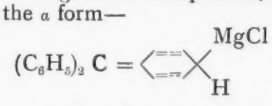


The possibility of such a formulation weakens the force of the proof afforded by these experiments, but on the other hand it is scarcely possible to produce material which would prove the quinonoid constitution of these double salts.

If, therefore, the quinonoid constitution of these double salts appears improbable, then we are still in ignorance with regard to the coloured sulphates. The point at issue is therefore whether a quinonoid structure is the cause of colour in the coloured sulphates or must another reason be sought for.

Baeyer in no way opposed the capability of these chlorides to rearrange themselves into quinone compounds, for in this manner he explained the entrance of three aniline molecules into tri-para-chlortriphenylchlormethane, when warmed, forming triphenylrosaniline by a threefold repetition of a quinone rearrangement.

A direct experimental proof that triphenylchlormethane is, at least as a derivative, capable of existing in quinone form has been afforded by the work of Schmidlin. The latter discovered the fact that triphenylchlormethane forms two isomeric magnesium compounds, one of which is unstable, viz., the α form—



passing by the action of heat into the rearranged normal β-derivative, viz.:—

$$(C_6H_5)_3C.\ MgCl.$$

The structure of the above isomeric magnesium compounds was proved by means of their behaviour towards benzaldehyde, whereby two different isomeric derivatives arise. The rearranged β-magnesium compound, formed by heating a benzol solution of the α, gives with benzaldehyde 30 per cent. of the theoretical yield of β-benzpinacoline, a body which arises by the oxidation in air of the β-benzpinacoline alcohol first formed. In many experiments tetraphenylethylene was formed by the splitting off of water from the β-benzpinacoline alcohol. The original α-magnesium compound forms with benzaldehyde a compound isomeric with β-benzpinacoline and for convenience designated γ-benzpinacoline, but proved to be identical with para-benzoyltriphenylmethane. Although this substance can only be isolated to the extent of 10-20 per cent. of the theory, yet doubtless the whole of the magnesium compound reacts since a large quantity of the reaction product was obtained in the form of a yellow honey probably containing the alcohol corresponding to

para-benzoyltriphenylmethane. In no case in which the α-compound was allowed to react was β-benzpinacoline observed.

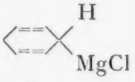
In each of the benzoyl compounds the benzoyl group occupied the position previously held by the MgCl group, and therefore from the two benzoyl compounds it is possible to deduce the formulæ of the two magnesium bodies, *e.g.*:—

$(C_6H_5)_2$. CH. C_6H_4. CO C_6H_5; $(C_6H_5)_3$. C. CO C_6H_5
b-benzoyltriphenylmethane -benzpinacoline

↓ ↓

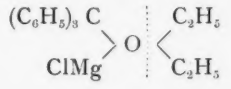
$(C_6H_5)_2$ CH. C_6H_4. MgCl $(C_6H_5)_3$. C. MgCl
α-magnesium compound β-magnesium compound.

In favour of the formula for the α-magnesium compound we have the great tendency of this substance to rearrange itself, and the only possibility which exists is a formula corresponding to the quinone structure proposed by Kehrmann for triphenylchlormethane. The two isomeric magnesium compounds must therefore possess the following structures—

$(C_6H_5)_2$ C =  ; $(C_6H_5)_3$ C. MgCl

α-compound β-compound.

The differences between the isomers have been demonstrated by their behaviour towards other reagents. While acetaldehyde, acetone, and acetylchloride did not react with either of the magnesium compounds, benzyl chloride would only affect the β-compound, forming unsymmetrical tetraphenylethane, and m-nitrobenzaldehyde appeared to work simply as an oxidising agent forming triphenylcarbinol from the α-body. By the formation of triphenylcarbinol, however, other unknown influences may play a part, analogous to the remarkable behaviour observed in the decomposition of the magnesium compound should the ether employed have contained a trace of moisture. In this case triphenylcarbinol is obtained instead of triphenylmethane and triphenylmethyl. Grignard expressed the opinion that hereby a decomposition of the complex ether magnesium compound has taken place in the manner denoted by the dotted line in the following diagram—



Analogous in every way to the behaviour of benzaldehyde is that of cinnamic aldehyde, which gave two isomeric cinnamoyl compounds corresponding to the benzoyl derivatives. A further correspondence between these two sets of compounds lay in their behaviour towards concentrated sulphuric acid.

Para-benzoyltriphenylmethane and para-cinnamoyltriphenylmethane derived from the α-magnesium compound dissolve in concentrated sulphuric acid with a yellow colour; the β-compounds on the contrary give no colour.

It was with great interest that experiments were conducted with the object of finding whether tri-tolylchlormethane would give two similar isomeric magnesium compounds. These experiments, however, were very difficult to perform since the tritolylchlormethane appeared to react with magnesium very tardily. In consequence only a very small amount of a magnesium derivative could be obtained, the existence of which was proved by allowing carbon dioxide to react with the reaction product whereby a small quantity of tritolylacetic acid was formed. The action of benzaldehyde under many different conditions always gave the same reaction product. From these observations it appeared that only one of the two isomeric forms which tritolylchlormethane might yield with magnesium is stable, viz., that corresponding to the normal β-form.

$(C_6H_4\ CH_3)_3$ C. MgCl.

As a bye-product in the preparation of the α-magnesium compound of triphenylchlormethane, triphenylmethyl is obtained in accordance with the equation:—

$(C_6H_5)_3$ C. MgCl + $(C_6H_5)_3$ C Cl = $MgCl_2$ + 2$(C_6H_5)_3$ C

and this is oxidised in the air to a stable peroxide. In the case of tritolylchlormethane it was never found possible in any of the magnesium experiments to isolate tritolylmethylperoxide. When magnesium reacted with tritolylchlormethane an intense orange yellow colour was noticed, probably due to the formation of tritolylmethyl. This intense colour disappeared on heating its ether solution a short time, an observation in accord with that of Gomberg. The latter observed that coloured solutions of tritolylmethyl, when allowed to stand in an atmosphere not containing air, became decolorised after a short time and then when exposed to air yielded no peroxide. When the above solutions were evaporated there remained an uncrystallisable gelatinous product which, when completely dried, had changed into a glassy mass. Gomberg was of opinion that this mass contained a polymerisation product of tritolylmethyl, analogous to that which triphenylmethyl forms in the presence of hydrochloric acid, viz., benzhydryltetraphenylmethane. While triphenylmethyl may be kept for years in a closed bottle, either in solution or in the solid state, without losing its capability of forming peroxide when exposed to air, tritolylmethyl on the other hand appears to be extremely unstable.

The action of magnesium on tritolylchlormethane appears to form a magnesium compound, which, however, immediately reacts with the unchanged tritolylchlormethane forming tri-tolylmethyl, but this at the temperature of boiling ether quickly polymerises. Therefore, after the decomposition of the excess of magnesium used in the experiments, we obtain, not tritolylmethane, but a glass behaving mass corresponding to the product which Gomberg had isolated in a different set of experiments.

(*To be continued.*)

Part IV.—"The Hexaphenylethane Problem."

THE number of bacteria contained in milk increases very rapidly from the moment of milking for a certain time, and then slowly decreases. Some bacteriologists have attributed this phenomenon to a bactericidal power possessed by the milk due to some unidentified ingredient. Experiments have been made to isolate this hypothetical substance, which appears to remain active up to a temperature of 140 deg. F. The milk was filtered through a porcelain cylinder, and the filtrate obtained showed greater germicidal power than ordinary milk, but no conclusive results were obtained. The real explanation of the germicidal power of milk is much simpler. The acidity of milk continually increases with age and thus milk continually becomes a less favourable medium for the growth of bacteria. The bacteria also have to contend with the lactic ferments, which develop very rapidly in sour milk, and are generally victorious in the struggle for existence. It is for this reason that the lactic ferments are employed in therapeutics.

XUM

The Meteoric Showers of April and May.

By W. F. DENNING, F.R.A.S.

THE April meteors are interesting as occurring at a period of the year when phenomena of this kind are scarce. Nothing very special indeed offers itself to the observer between the shower of January 2-3 and the last half of July, when Aquarids and early Perseids supply plenty of bright objects for record. There are the Aquarids of May 1-6 it is true, but their radiant only rises just before daylight becomes strong enough to overpower meteoric appearances of ordinary kind.

April weather is often inviting to the observer and clear skies at this particular epoch have frequently enabled the Lyrids to be witnessed under good conditions. But the display is not like the Perseids in rarely disappointing expectation. The Lyrids are often scarce even at the time of their computed maximum, and the observer may be surprised, not at the frequency of meteors, but at their extreme rarity.

In 1803, on the night of April 19, there was a very abundant display which attracted much notice in certain parts of America, but no really brilliant exhibition appears to have been offered by this stream ever since. There have been some fairly active returns of the meteors, but they have never been sufficiently numerous to warrant the displays being considered as of first-class importance.

The duration of the richer part of the display is usually very brief and confined to a few hours, but stray Lyrids may be detected between about April 17 and 24. The place of the radiant appears to travel eastwards 1 degree diurnally, but the writer must admit that the evidence he has obtained to prove this is of somewhat scanty character, though he regards it as conclusive.

The Lyrids have a cometary association—that is, their orbit as computed agrees with that of a comet seen in 1861, but the elements may quite possibly only bear an accidental resemblance. Absolute proof of identity cannot be said to have been obtained as to the comet and the meteoric shower.

This year moonlight will interfere with observation as our satellite will be gibbous and visible during the whole night. But the best meteoric displays sometimes present themselves under adverse circumstances, and so observers should watch the heavens on April 21 in the hope of seeing something of this interesting shower. It furnishes bright, streak-leaving meteors from a radiant at 271° + 33° and it is very desirable to look for its visits every year, for negative evidence of its presence will possess a certain value. And as we know little of the period of the swarm a really brilliant and numerous exhibition may take place in any year and at a time when nothing of the kind is expected.

The May meteors were discovered by Captain Tupman, R.M.A., when cruising in the Mediterranean in 1869-71. This system has a special significance, because of its suggested association with Halley's comet, and during the present spring it will be of great importance to ascertain whether the shower develops special intensity. The comet being so close to that part of the orbit near which the earth passes in the first half of May, there should be a fine display of shooting stars if the earth really encounters any of the cometary material. A sharp watch should be maintained before sunrise on the mornings of May and when the earth is likely to be involved with the comet's tail on May 19 the sky should be carefully observed for any abnormal aspect.

The Aquarids are bright long meteors, often with flights of 40 degrees or more, and I witnessed a fairly rich return of them in 1886. That, however, is the only year when they were seen at Bristol, but they have not been as thoroughly studied as they should be.

Whether or not their association is proved with the comet of Halley will depend upon the results obtained this year, for if they show no striking abundance the fact will at least induce the belief that the assumed connection between the meteors and comet is but a chance similarity, and must be disregarded pending further evidence. In the case of the Bielan comet and Andromedid meteors observations have proved that the swarm of fragments precede and follow the cometary nucleus over a vast range of the orbit. If, therefore, we see no bright display of meteors either this year or in 1911 we must assume that the May Aquarids of past years probably belong to some other cometary system than that of the famous Halley.

Only one member of this special shower has had its real path computed, and that was in 1900, May 3 ($13^h\ 58^m$), when Professor A. S. Herschel at Slough and Mr. Bridger at Farnborough saw a meteor varying between 5th and 2nd magnitude travelling along an extended course of 155 miles from a radiant at 337° ± 0°. I computed the height as from 54 to 49 miles, and the observed speed 28 miles per second. This is a velocity much less than that which a meteor belonging to Halley's comet should have, the theoretical value being more than 40 miles per second. The long horizontal flight of the object recorded in 1900 may have led it to encounter atmospheric resistance in sufficient degree to considerably reduce the original speed. At any rate, the slow rate observed rests upon very trustworthy evidence, and may be accepted as real. The same peculiarity has been found in regard to meteors belonging to certain other showers. Objects traversing our air-strata in long horizontal flights move with a much slower rate than theory would suggest, and this feature needs fuller investigation.

Anyone can mark for himself great apparent differences in the flights of meteors from one and the same shower at various hours of the night. Let the observer watch the Perseids of August between 9^h and 10^h p.m., and again between 2^h and 3^h on the following morning. He will see that at the earlier period of the night the meteors have much longer flights and seem to travel far slower than those which appear in the morning hours. The same thing applies to the Leonids of November 13-16, for before midnight they are strikingly slower and longer than in the two or three hours preceding sunrise.

FROM time to time estimates of the power of a lightning discharge are published which would give one the idea that every discharge represents an enormous current. On this point Prof. Elihu Thompson, lecturing at Princeton University, on "Atmospheric Electricity," recently stated that "we must, however, be cautious not to exaggerate either the current or the potential present in a lightning flash. The current in a flash may at times be only a few amperes or may in a heavier discharge reach perhaps hundreds or approximately in extreme cases some few thousands of amperes. It is doubtful if the potential much exceeds at any time more than a few millions of volts as it is probable that small local breakdowns start the disruptive process which then extends through miles of length."

ELECTRIC power is furnished to Helsingöre, Denmark, from Sweden by means of a cable which runs under the narrow sea separating the two countries. The power is generated at a 300 ft. fall of the Laga River in Sweden, and is conducted to the coast by means of cable, where it connects with a submarine cable three miles long. The transmission of power by means of a submarine cable is quite unusual.

The Application of the Telephoto Lens to Photomicrography.

By HARVEY COLLINGRIDGE, B.Sc. Lond., A.M.I.C.E.

FOR photomicrography at low powers a ¼ plate camera fitted with a good lens provides a convenient and speedy method of making records.

With the object, however, of getting photomicrographs 3 to 5 times larger the writer has tried several experiments with the telephoto lens which he ventures to think render the process as easy as with the ordinary photographic objective alone.

The rays of light projected through the eyepiece of the microscope as used visually are practically parallel, hence a camera focussed for infinity will give us a well-defined image on the focussing screen needing perhaps only the smallest adjustment to give a critical image. But for the reason that a ¼ plate camera is usually fitted with a lens of between 5″ and 6″ focus the limit of possible size of image is apparent. With a 5″ lens the photograph will be approximately half the size of the image at a 10″ visual distance.

It is at this point that the telephoto lens comes to our aid, and for the benefit of those who have not had practical acquaintance with this valuable tool a brief *résumé* will be here given of the manner of its working.

The telephoto lens is a concave lens incapable by itself of forming a real image; it is attached in a mount (usually adjustable) between the positive lens and the focussing screen, and its function is to lengthen the focus of the positive lens without (and herein lies its value) proportionally lengthening the "back focus."

The separation of or the distance between the positive and negative lenses determines the ratio of magnification.

The magnification possible with a given camera extension may be simply determined by dividing the distance between the negative lens and the focussing screen by the focal length of the negative lens and adding 1 to the quotient. The focus of the negative lens is usually half that of the positive, but may be as small as ¼.

A numerical illustration will perhaps make the matter plain.

With a camera fitted with a 5″ lens and extending to give 10″ between the negative lens and the focussing screen we should get, with the positive lens alone and at 5″ extension, an image half that of the visual at 10″, or in other words half that formed by the eyepiece alone at 10″ distance.

With a 2½″ negative lens we get an image $\frac{10}{2 \cdot 5} + 1$, or 5 times the size of the image formed by the positive alone, or 2½ times the size of that formed by the eyepiece alone.

With a more powerful negative lens of 1¼″ focus with 10″ extension we should get a magnification of 9 over the positive alone; or in other words the same size as the image formed by the eyepiece alone at a distance of 45″. The gain in steadiness and in ease of manipulation of a camera 10″ in extension compared with that of one with 45″ extension is apparent.

As regards practical details the writer has found an acetylene bicycle lamp a suitable illuminant. The positive lens may be stopped down to F/11, as the available aperture is regulated by the eyepiece of the microscope.

An exposure of 1 minute being about right for the camera lens used without the telephoto attachment, an increased exposure varying as the square of the magnifications may be given for those taken with the telephoto lens added. Rodinal 1 in 50 or Glycin, according to Hauff's formula for stand development, are excellent developers.

The following is a table of data relating to the photomicrographs:—

Fig.	Mag.	Optical Data.
1	× 37	No. 2 eyepiece and ⅜″ objective. Camera 7″ extension.
2	× 45	No. 2 eyepiece and ⅜″ objective. 5¾″ positive lens. 7″ extension.
3	× 130	No. 2 eyepiece and ⅜″ objective. 5¾″ positive lens. 2½″ negative. 7″ extension.
4	× 205	No. 2 eyepiece and ⅜″ objective. 5¾″ positive lens. 1 3/16″ negative lens. 7″ extension.
5	× 200	No. 2 eyepiece and ⅛″ objective. 5¾″ positive lens. Camera 7″ extension.
6	× 610	No. 2 eyepiece and ⅛″ objective. 5¾″ positive lens. 2½″ negative. Camera 7″ extension.

Comparing Figs. 2 and 6 we see that by use of a telephoto lens we increase our magnification from 45 to 610 with the same camera extension. The arrangement as Fig. 4 only gives us the same total magnification as Fig. 5, but we get the advantage of better definition and a far bigger field.

Fig. 6, of course, gives us a photograph three times the size of Fig. 5 and of excellent definition. These telephotomicrographs were taken without the aid of a special photomicrographic camera, the hand camera being simply placed in line behind the microscope.

It will be noticed, of course, that due to all of the objects or parts of one object not being in one plane, the definition is not critical all over; this, of course, is inevitable.

The Riddle of Tibet.

THE flight of the Dalai Lama into Northern India recalls the fact that his brother pontiff, the Tashi Lama, once visited the same region. From travellers' accounts it would seem that of these two reputed incarnations of Buddha, the Tashi Lama possesses the more attractive personality, if, indeed, an incarnation can be said to possess a personality of its own. Dr. Sven Hedin, whose fascinating book, "Trans-Himalaya," is read by all students of the Tibetan enigma, describes the smile of the Tashi Lama as being of surpassing sweetness. That the Tashi Lama is not altogether impervious or hostile to Western ideas is proved by his friendly reception of Sven Hedin. The worthy doctor, who evidently possesses a good deal of the art of the diplomat as well as the courage and resource of the explorer, having secured an audience with the Tashi Lama, was puzzled to know what gift he should present, in accordance with oriental custom, upon the occasion of his visit. At last he hit upon the idea of offering a very elegant aluminium medicine chest of English make, which he had brought with him, and which had often been used on the march, and had been an object of special admiration and curiosity to his followers. "The chest itself," says Dr. Sven Hedin, in his description of the incident, "of aluminium and all its elegant tabloid boxes, bottles, cases, bandages, and instruments were rubbed and polished up till they shone like silver, and then wrapped in a large piece of silk which Nahamed Isa had picked up in the bazaar, for it was next day to be my friendship's offering to the Pauchen Rinpoche, or Tashi Lama." The following day Dr. Sven Hedin was introduced into the presence of the Tashi Lama, and he continues: "When we had conversed for two hours, I made a move to leave him but the Tashi Lama pushed me back on to the chair and said, 'No, stay a little longer.' Now was the time to present my offering. The elegant English medicine chest was taken out of its silk cloth, opened and exhibited and excited his great admiration and lively interest. Everything must be explained to him. The hypodermic syringe, in its tasteful aluminium case with all its belongings, especially delighted him."

XUM

Musical Scales.

By JOSEPH GOOLD.

(Continued from last month, p. 99.)

Functional Dissonances.—A functional dissonance may be shortly defined as a consonance provoking unrest. More explicitly it is a note, chord, or combination of notes, not physically dissonant, but which produces a sense of unrest or instability demanding some form of resolution.

Some degree of unrest is attributable to every note and every chord in the key except the major tonic; for no other note or chord expresses a complete sense of satisfaction. (The minor tonic expresses not satisfaction, but resignation: hence comes the possibility of the demand for the "Tierce de Picardie." The opposite demand for a minor 3rd to usurp the place of a final major 3rd is impossible.) It is the effective marshalling of these gratifying, but generally unsatisfying, functionaries that gives dynamic impetus to musical movements and constitutes the special art of the musical composer.

Chief amongst the single functional dissonances are the down-measured scale notes D♭ F A♭ (minor 2nd, subdominant, and minor submediant, see ii.). These originally inverse measurements are unstable singly and in all their combinations. They are generally described as 7ths or 9ths, and, of course, they are often compounded so as to be physically dissonant with other notes of the chord in which they appear; but I am not dealing with physical dissonance. I am insisting on the fact that all notes owing their places in the scale to measurements which are inversions of upward or major measurements are functionally unstable; and that this instability (amounting in most cases to functional dissonance) pervades all their harmonic combinations. It does not follow that these dissonances need to be resolved according to any given pattern; but apart from arpeggi and sequences, they generally require to be followed by the nearest note of the tonic chord.

Although not ungratifying, down-measured intervals are certainly unsatisfying. Indeed, it would seem that so far as concerned the immediate static effect of any tonal combination in a musical passage, these two qualities (gratification and satisfaction) are, in very many cases, inversely proportional to each other. So that effects which in themselves are *most* gratifying are at the same time imperious in their demand for a satisfying element in the sequence. This is most obvious in the usual progressions of dominant 7ths, 9ths, augmented 6ths, &c.

N.B.—The augmented 6th is not a double-*rooted* chord as some theorists have supposed, but it is a double-*measured* and doubly-dissonant combination, consisting of 5th and 3rd in *one* measurement, taken upwards and downwards *from the same root* simultaneously; the root itself (which is generally the dominant) being the note of resolution demanded by both dissonances equally.

E.g., Augmented 6th, on A♭.

A♭ measures one 5th and one 3rd down from G the root
F♯ " " " up " "
Both resolve on G the root.

But even the *most* consonant chords of purely upward measurement, such as major tonic and dominant, are also unstable *in their inversions;* the most unstable being that in which the most perfect interval of the chord (the perfect 5th) appears in the bass. This is known as the $\frac{6}{4}$ chord, and in this case also the instability amounts to functional dissonance. Thus it appears that *in every case functional dissonance is due to inverted measurement.*

Every musician must be familiar with the fact that the 4th from the bass requires to be treated as a dissonance; the observations here adduced will serve to show him the reason why, and may thus enable him to replace bare dogma by scientific fact.

No consideration of the subject of functional dissonance can be complete without some reference to

The Harmonic 7th.—Very few have ever fairly heard the harmonic 7th (ratio 7 : 4) as a distinct musical interval, although perhaps still fewer are those who have not heard of it; whereas every musician will have heard the 7th harmonic (ratio 7 : 1), though mostly without knowing it. But for ordinary considerations it is not necessary to distinguish between them, because, as already observed, harmony is independent of the octave element.

This remarkable interval is both ubiquitous and unique. It is usually the most powerful of the harmonics not directly related to the scale. It belongs to no system of music, but there is no music without it. It forms no part of the musical scale, but yet exercises a profound influence on its functions. It is both consonant and dissonant; consonant inasmuch as it forms an essential element in the constituent parts of nearly all consonant sounds; dissonant, by substitution, inasmuch as it usurps the function of the dominant 7th with which it is closely associated by reason of its position in relation to the scale.

In order to understand this position accurately we must compare the magnitudes of the scale-ratios by means of some *standard unit interval.* Most convenient for this purpose is that very small interval of which the vibration ratio is $\frac{600}{599}$, nearly. This is really the 600th root of 2; so that 600 of such intervals multiplied together make just one octave.

The perfect 5th (ratio 3 : 2) = 351 of these same units
" major 3rd (" 5 : 4) = 193 " "

These figures are determined by means of the formula:—

$$x = n\,\frac{\text{Log } a}{\text{Log } 2};$$ where a = ratio to be measured; n = number of units in the 8ve.; x = number of units in the measured interval.

Thus, for 3 : 2 = 1·5;

$$x = 600\,\frac{\text{Log } 1{\cdot}5}{\text{Log } 2} = 600\,\frac{{\cdot}17610}{{\cdot}30102} = 351.$$

As the whole scale is measured in 5ths and 3rds, all other scale magnitudes are ascertained by simple addition and subtraction of these two intervals; we thus get the corresponding magnitudes here shown:—

442	193	544	295
249	0	351	102
56	407	158	509

Magnitudes of scale intervals in $\frac{1}{600}$ths of an 8ve.

A	E	B	F♯
F	C	G	D
D♭	A♭	E♭	B♭

Scale names corresponding to above magnitudes. (vii.)

N.B.—600 is added or subtracted, as required, to bring all magnitudes within octave limits.

Below, we have these same magnitudes arranged in scale order, together with their corresponding equal temperament magnitudes.

Scale magnitudes in $\frac{1}{600}$th of an octave—

C	D♭	D	E♭	E	F	F♯	G	A♭	A	B♭	B	C
0	56	102	158	193	249	295	351	407	442	509	544	600

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Equal temperament magnitudes—

0 50 100 150 200 250 300 350 400 450 500 550 600

Between A and B♭ comes the harmonic 7th = 484·4 and the ultra-scale 7th and B♭ (one 5th below F) = 498, which is in frequent use as the tonic 7th.

Now we are able to make a precise comparison of scale magnitudes.

The harmonic 7th we find is 498 − 484·4 = 13·6 units flatter than the dominant 7th.

How does this difference affect the potential influence of the interval in musical acoustics? Physically, the harmonic 7th is distinctly and beautifully consonant; as anyone can testify who has heard it with the major common chord on a heavy set of synchronising steel bars. Nevertheless, it is commonly supposed to be a dissonance. This seems all the more remarkable because its derivation is neither from *downward* nor from *double measurement*, as is the case (one way or other) with all other dissonances. But there can be little doubt that its dissonant character (or rather its dissonant reputation) is due chiefly to the fact that, owing to its close proximity with the dominant 7th in scale measurements it is liable to usurp the proper function of that interval. For although the harmonic 7th is never designedly employed in musical compositions, the wide persistency of its automatic assertiveness is much greater than is commonly suspected; and hence the fact of its large influence on practical music is not estimated at its full importance. Something of its ubiquity may be realised from consideration of the following facts.

The tone of a heavy steel plate is not less pure than that of the most perfect tuning fork; but the 7th partial tone can always be detected amongst its components, and its power and volume is usually such, that it (the 7th partial) can be made to "beat" with another plate of nearly similar pitch. These component tones are not to be confused with the tones proper to the natural divisions of the plate; they are the true harmonics of the fundamental tone, due entirely to the forced vibration of adjacent resonating materials, with rates of vibration which are whole multiples of the fundamental vibration rate.

Strings, pipes, membranes, voices, &c., are not less liable than steel plates to provoke harmonic action—not on themselves but *on adjacent resonating materials*.

Thus it is that every tonic chord contains a hidden but suggestive whisper of the next flat key. I think it will be found that this practical ubiquity of the 7th partial has had, and must always have, a wide, although unsuspected, influence on musical evolution—*but not on the scale*.

It is probably this hidden function of the harmonic 7th that gives rise to a sort of ear-bias or universal tendency of mind which makes it easier to modulate toward the flat keys rather than in the opposite direction. And further, it is the recognition, by "unconscious cerebration," of the necessity for counteracting this otherwise unaccountable tendency, that has led composers to adopt the prevalent rule of modulating *first* to the dominant, thus ensuring that the inevitable return to the tonic shall be rendered more acceptable by the unseen co-operation of the natural downward tendency of harmonic influence. The common tendency amongst beginners in vocal scale practice to sing the flat, in place of the sharp, 7th, is evidently due to the same cause.

Tonic Minor v. Relative Minor.—The many controversies on this subject have provided us with little more than a mass of dogmatic confusion. As in most things human, the question is chiefly one of comparison.

Whether any minor passage is really in the tonic minor or in the relative minor depends *entirely* upon the context. The notes or the scale of the passage are in either case the same, *e.g.*—

In Ex. 1 the first phrase is in the relative minor of C.

In Ex. 2 the same phrase is in the tonic minor of A.

The *relation* between the major key of C and its relative minor of A is evidently due to the double function of the major 3rd E, as mediant of C and dominant of A; and the necessary ambiguity for this transition is probably the result of our making C E the *central interval* for the time being, instead of C G.

Viewing the Harmonic chromatic system in its natural mathematical aspect, we find no trace of evolutionary action. Nothing can be added to it, nothing can be taken away, nothing can be altered without destroying the symmetry, the identity, and the perfection of the whole. It is no more capable of evolution than is a circle or a square. It has remained *hidden*, but changeless through all past history. Although unseen, it has not been inoperative. It has constituted, and must for ever constitute, the unvarying guide or limit, toward and within which all attempts at the realisation of melody or harmony must pursue their fluctuating courses. For in the spontaneous division of the octave, the human constitution (which incorporates the very principles of the scale itself) is incapable of choosing or employing any other divisor than the major 3rd and perfect 5th or their compounds. On the other hand, although the abstract form of the scale remains absolutely unalterable, its limits offer no impediment to the expansive efforts of intense mental activities to find new and suitable forms of expression. In other words—the perfect definition of the scale-nucleus is no barrier to the free employment of more complex measurements in the unlimited field beyond. What *is* imperative in the excursions and innovations of extended modulations is, simply, that the *centre of measurement shall never be lost*, either to the performer or to the listener. It may be *changed* as often as art and good taste require; but if lost Tonality and Art must also disappear.

Mankind has long been familiar with some of the facts here mentioned, whilst others have never before been brought to light; but from eternity to eternity (whatever our knowledge or our ignorance of the subject) the mathematical structure of the musical scale has remained, and must continue to remain precisely what it is at the present day. Because man (like all the rest of creation) is eventually bound to do, of his own choice, that which is truly the easiest thing possible; for the inexorable and inviolable Power that *dominates* his ultimate choice is Almighty Truth.

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Pain: Its Significance and Value.

By C. E. LEA, M.D.

PAIN in man is a mental perception, dependent on consciousness. Like all other forms of perception, sight, hearing, touch, and so forth, pain depends for its production on four things: (1) An external stimulus; (2) a surface capable of receiving such stimulus; (3) a means of transmission; and (4) the brain. Life as we know it is made up of perceptions and the conceptions created thereby. Their variety is enormous in the higher forms of animal life, but such variety is mainly the result of the modification of certain portions of the receptive surface (the body) for the reception of particular forms of stimuli. Thus sight is the perception created by the effect of a particular form of stimulus, namely, rays of light, upon a portion of the body surface specially adapted for its reception, namely, the retina of the eye. Similarly with hearing, taste, sense of position in space—all sensations, in fact, but all are dependent for their production on the same four essential entities. So that we see, as regards the mechanism of its production, pain differs in no respect from other forms of perception. But it is when we come to consider the causes and effects of pain that we see how fundamentally and vitally it differs from other perceptions. Pain or its analogue, reaction to injury, existed long before such finished articles as sight, hearing, and other special senses had issued from Nature's workshop; the inherent faculty of all living matter, that of avoiding injurious stimuli, had attained a considerable degree of development long ages before so complicated a structure as the brain was even thought of. So that it is reasonable to suppose that even in man, in whom we find pain but one variety, and that the least frequently aroused, of perceptions amongst others upon which we mainly depend for our conception of life, we shall find certain differences between pain and other perceptions in which we can trace its inherent and pre-eminent importance in relation to the primitive laws of existence.

One obvious distinction is that pain can be produced in *every* tissue of the body; other perceptions only by limited and specialised portions. A second distinction naturally follows from this, namely, that all nerves are capable of transmitting the stimulus of pain, whereas special nerves are frequently necessary for the production of other perceptions. Pain is general in character; other perceptions special. Just as we find in Nature the most vital functions performed by the most elementary, the least specialised, tissues, so we find pain produced by the most elementary mechanism. We must conclude, then, that the function of pain is something vital to the well-being of the organism. Pain is further analogous in its significance to the more vital functions in that, like the heart, respiratory and digestive mechanisms—all organs essential for existence—it is little influenced by the will. The beat of the heart, the number of respirations per minute, the digestion of food all pursue their even tenour largely independent of the will and the grosser effects capable of being produced by volition; similarly, no man can voluntarily banish pain, and in all the varied conditions of conscious life pain is capable of being excited.

Lastly, pain is capable of killing the organism, and even its tolerably frequent occurrence is able to modify profoundly the life of an individual.

The causes and effects of pain, we see, are of fundamental importance to the individual. Only in its mechanism does it show any analogy to other forms of perception, and in man even such mechanisms have become so modified that pain appears to be only an occasional or accidental perception, whereas developmentally we see that it is rather all other perceptions which are accessory or accidental, dependent as they are for their production upon certain specialised structures, useful but not essential to existence. The significance of pain must be something elemental in Nature—something bound up with the existence of life itself. Briefly stated, its significance is protection—protection in the sense that by pain the organism is made aware of injury. How this protective function avails is evident throughout the whole scale of animal life. Reaction to stimuli, injurious or beneficial, is the elemental function of living matter; movement incurred thereby is the chief objective sign of life. Such movement is directed mainly for the purposes of attack and defence, dependent as the organism is on such powers for the obtaining of food. When a separate organ was developed for directing those movements, namely, the brain, it was by the intelligence with which such movements were directed, allowing the animal to discriminate between good and evil and act accordingly, that it was enabled to maintain its existence.

It was in proportion to the capacity of the organism to create for itself an environment with the least possible number of causes for injury that such organisms rose in the scale of life. Those animals incapable of avoiding pain, whether due to the overpowering number of possible agencies or to their lessened sensibility, died; those quickest to learn the causes producing pain and profit thereby lived. The lesson of pain thus became so ingrained in animal life as to become in the higher animals what we call, for want of a better name, instinct. The instinct of avoiding pain and its corresponding mental attitude, the fear of pain, is the strongest of all instincts, and this we should expect, seeing that it has its origin in the causes allowing the very existence of this species. Man, by his superior intellect, has, of all animals, created for himself an environment where he is least subject to pain. He, of all animals, is the least afraid of pain. He alone, perhaps, is capable of performing occasional acts which he knows will cause him pain. His brain is so crowded with all kinds of perceptions and conceptions, due to his dominant intellect, that there is little room in it for that dread of pain ever present in the lower animals. Into his cool and balanced judgments there seldom enters the thought whether physical pain will or will not be induced by his actions. Pain has come to be a side issue, an accident, in his life. And so he is in danger of losing his sense of proportion as to its significance. New agencies for causing pain, in the form of accident or disease, spring into prominence, and it is only in proportion to how, by means of his intellect, he combats such agencies that he can maintain his existence. Let us consider some of the means by which in man its protective functions are fulfilled.

Incidence of Pain.—Of the four factors necessary for the production of pain in man the brain and the nerves are the most constant. The variable character of pain as we know it is due to differences in the character of the stimulus and the stimulus-receiving surface; in the former as regards its degree and capacity for injury, in the latter the portion or portions of the body affected.

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Pain occurs in man under two conditions, accidents and diseases. It is a useful practical distinction, though pathologically it cannot be recognised since in both conditions the causes and effects are identical, namely, injury and tissue response thereto. Accidents usually affect what we call the *skeletal* portions of the body, namely, the whole limb system, and the integument; diseases more frequently affect the *visceral* portions, the organs concerned mainly with the essential functions, circulation of the blood, respiration, and so on. Bearing this arbitary but useful distinction between the two body systems in mind, one may recognise considerable differences between them both as regards their characters as stimulus-receiving surfaces, and the character of the stimulus for injury to which each is more particularly liable. And it is these differences which are responsible for the different effects of accidents and diseases and the variable character of the pain produced in the two cases.

Skelctal and Visceral Injuries Compared.—This distinction is not merely morphological, for the division of the body into a mainly mobile or skeletal portion and a mainly assimilative or visceral portion may be said to have begun with the development in the primitive organism of a specially protective external surface, the consequence of which was that upon the remaining internal parts devolved the conserving, life-maintaining mechanisms. And throughout the whole scale of animal life, culminating in man, all the extraordinary morphological variations have developed along the lines whereby these two mutual functions can best be maintained under varying circumstances.

In the Figure (1) man is compared diagrammatically to the primitive organism. The shaded portions correspond in each case to skeletal, the unshaded to visceral portions. The chief modifications to which one would direct attention are:

1. The great preponderance of skeletal to visceral tissues in man. By weight this is roughly in the proportion of ten to one.

2. The great preponderance of surface of skeletal over visceral tissues. Just as an indented coast line renders invasion by an enemy easier because of the increased points of attack, so man as compared to primitive organisms presents a much greater extent of vulnerable skeletal surface.

3. Limb arrangement best adapted for mobility, whereas the viscera, requiring as little mobility as possible for their functionating, are placed in the least mobile part of the body, namely, the trunk.

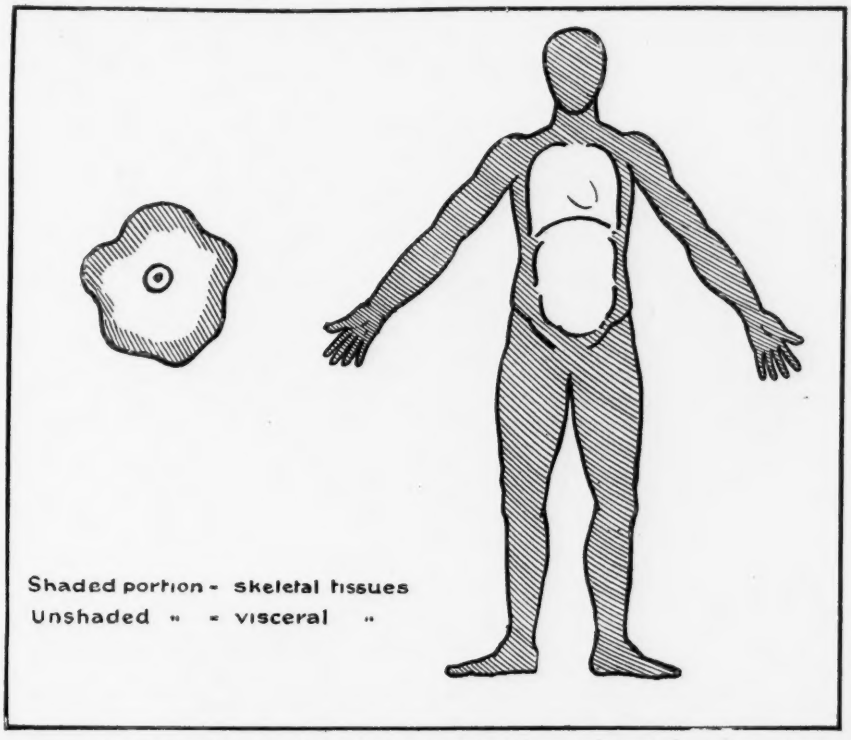

Diagram to show comparative extent of skeletal and visceral tissues in primitive organism and man.

Such modifications have altered considerably the distribution of what one might call the resistance-to-injury powers of the body. Functionally, the skeletal system is especially exposed to injury because of its active movements and dangers often associated with them; anatomically, also, its superficiality and extent make it more liable to gross forms of injury than the deeper seated viscera. The visceral system has become so protected anatomically that it is rarely injured by the grosser forms of injury; the paths for external injurious agencies to reach the visceral system have been so narrowed down that practically the mouth is the only channel left; and so it follows that, given consciousness and sanity, the only injurious agents capable of attacking the visceral system must be of two classes, those which enter the mouth consciously, that is, with the volitional consent of the individual, and those too small

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to be seen, which enter, therefore, unknown at the time to the individual. The former class comprise all errors of diet, known or unknown to the individual; the latter class comprise the host of bacteria responsible, as we know, for the great majority of visceral diseases.

We thus see how the alterations of the body conformity have correspondingly modified the type and incidence of injurious agencies; and why the grosser injuries usually affect the skeletal system and are embraced under the term accident, whilst dietetic and bacterial injuries mainly attack the visceral system and cause what we call disease.

SKELETAL AND VISCERAL MECHANISMS FOR PAIN.

(1) *Skeletal.*—We take this first because its effects are more readily seen and also because, since the skeletal system is more liable to injury, it is here that we would expect to find the mechanism for pain the more highly developed, thus compensating to some extent its greater vulnerability. The skin of the body is particularly sensitive to pain. A pin scratch is as readily felt as a severe cut. Nothing is more painful than a superficial burn, and this is because it exposes the delicate bulbous nerve-endings which lie just beneath the skin. It is known that the shock induced by such a burn involving more than one-third of the total skin area always causes death. The result of this skin sensitiveness to pain is that no injurious agent can come in contact with it without the individual being made aware. When we come to the muscles, forming as they do the chief bulk of the skeletal system, we find here also a sensitiveness to pain, though it is exhibited in a different manner. Muscular fatigue and its accompanying stiffness is the effect of accumulated exhaust products on the nerve-endings in the muscles. The pain of cramp, which is muscular spasm, is well known. Muscular effort may be closely allied to pain, as one may see in the face of the athlete when breasting the tape after a strenuous effort. Bone, the skeletal framework, is capable of causing great pain, as in fracture, though such pain is naturally of rarer occurrence. We may say, then, that no injury can affect the skeletal system without pain being at once elicited.

(2) *Visceral.*—How does the visceral system compare? It is relatively much less sensitive to pain. Surgeons have discovered that such organs as the lung, stomach, and even the heart may be handled without the patient feeling anything. Stimuli, which would cause pain if applied to the skeletal tissues, may fail to elicit pain in the viscera. The character of pain of visceral origin often differs from that of skeletal. It is often more a feeling of vague discomfort. Frequently the pain is referred by the patient to a part quite distant from the organ which is really giving rise to it, and this adds to the difficulty of interpreting its significance. But though to the smaller injurious stimuli the viscera appear rather insensitive, injuries, endangering life, especially if of sudden onset, are often associated with the most severe pain, massive in type, persistent in character, and tending to increase rather than diminish, so that the viscera cannot be regarded as having lost entirely their capacity for creating pain. But since visceral injurious agents are mainly microbic or dietetic, so that by their nature they fail to give rise to such sudden injury, we find that most diseases run their course without giving rise to physical pain in its strict sense.

Value of Pain.—How have these modifications influenced the protective mechanisms of pain in man? Pain cannot be dissociated from the conditions which give rise to it. Pain, *per se*, is an evil in that it may endanger life, and if prolonged, may affect the whole body adversely. But this potential disadvantage is far outshadowed by the advantage it bestows of compelling attention to the injurious agents producing it, the first and essential step before the removal of such agents can be effected and the remedy of the tissues injured rendered possible. The cause of pain is practically of more importance than its effects. How is this "danger-signal" function of pain effected in man?

Insurance companies, those faithful barometers of the vicissitudes of human life, class all ills under the usual headings, accidents and diseases, and base their premium rates on their relationship to the probable duration of life. Their figures fully bear out everyone's experience, namely, that diseases as a whole are more dangerous to life than accident. Even in war, where conditions for the latter are so prominent, it is often the more subtle microbe enemy which demands the bigger death-roll. We would suggest that the greater fatality of disease is due largely to the lesser amount of physical pain associated with it (as distinguished from discomfort or distress), this disadvantage (if pain is protective) being caused by the lessened visceral sensibility and the frequent insidious nature of the injurious agent. How is this suggestion borne out by practical experience? The protective value of pain may be most easily understood by comparing its effects in typical injury of skeletal and visceral tissues respectively. Let x = the moment of reception of injurious stimulus, y = the moment when the pain created thereby is felt, and z = the hypothetical moment when either recovery from such injury may be said to be complete or death ensues.

Skeletal Injury.—A man falls down and breaks his leg. Pain is immediate and severe; that is, moments x and y are simultaneous. Not only is the site of the injury known at once (a point of some importance, as we shall see later) but the pain compels rest to the part, assistance is procured, and given suitable treatment, recovery is but a matter of time, such time, y-z, depending, of course, on circumstances. This simultaneous occurrence of moments x-y is common to all gross accidents whether skeletal or visceral, though naturally, as we have seen, it is the former class which are much the more frequent.

Compare this with what happens in so typical a *visceral* injury or disease as pulmonary tuberculosis (consumption).

Here, just as in skeletal injury, a stimulus and a stimulus-receiving surface are necessary. The stimulus in this case is the tubercle bacillus; the surface is the lung. The means by which the stimulus reaches this surface is by practically the only channel available for visceral injury, the mouth. But here we notice a great difference with regard to the incidence of pain. Moments x and y are widely separated. x is unknown since no one can feel the first attack of these particular germs. y may or may not occur, for pain is not a frequent occurrence in consumption. So that here we have the injurious agent damaging the tissues through the whole period x-y, and such time may extend over years, and yet the subject is unfortunately unaware of the injury because pain has not come to his rescue. The disastrous result of this prolonged x-y period is familiar to us all, for it may be taken as a general rule that the longer this period the longer the y-z, or period of recovery. It may be said that all accidents and diseases do not follow so definitely on

these lines, and that accidents and diseases are by no means limited to skeletal and visceral tissues respectively. This is no doubt true. Distinctions so sharp as we have drawn do not occur in Nature, but such broad generalisations are of use in enabling us to distinguish common cause and effect amongst phenomena apparently dissimilar. Generalisations, applicable, as we have seen as regards pain, throughout the whole animal world, are necessary to a proper interpretation in man where its phenomena have become so modified and intricate through the processes of evolution.

There are cases where skeletal injury manifests itself mainly in the visceral system. A familiar example is blood-poisoning following a septic wound. But the alarming symptoms here are microbic and the skeletal injury has only been the means of allowing entrance to such germs through an unusual channel. Such symptoms, as we should expect, are not accompanied by any more physical pain than the original wound occasions. Again, visceral disease may manifest itself mainly in the skeletal tissue. Here we should expect the latter to occasion the most pain. Rheumatic fever is a typical example. This is essentially a visceral disease. It is occasioned by the entry, *via* the mouth, of the germ causing it. It is followed sooner or later by severe pain in the joints, which swell up. The pain compels attention, and is speedily relieved by suitable medicine. But the organ principally damaged, namely, the heart, does not evoke pain, consequently the doctor finds it more difficult to enforce the rest required for this organ than for the joints, because the latter are painful, the former is not. Consequently the joints frequently go on to complete recovery whilst the after effects on the heart are too often fatal. Another visceral disease affecting mainly the skeletal system, but in which pain is absent throughout, is rickets. This disease occurs in children and is due to errors of diet—mechanical, not wholly microbic, agents this time, but equally capable, given sufficient time through which such errors are committed, of producing injury. Here the chief symptom is skeletal, namely, bony deformity. But because no pain is elicited it is not till the deformities are obvious to the eye that the injury is detected. The slow and insidious character of the skeletal damage is responsible, in this case, as in most visceral diseases, for the absence of pain, showing that skeletal as well as visceral tissue is incapable of eliciting pain if the injurious agent is not sufficiently gross in character.

Though skeletal injuries are usually gross in character such is not always the case. As in visceral disease, *e.g.*, rickets, small successive injurious stimuli prolonged over sufficiently long period of time, in the skeletal system, are capable of equally grave injury. A life of continuous over-muscular exertion may result in premature muscular weakness; more frequently it may affect the visceral tissue adversely. Heart disease is frequently induced in this manner. No pain announces the overstrain of this organ. The individual little knows he is continually beating a tired horse, till with tragic suddenness the heart at last gives way, withholding to the end the warning note of pain. Similarly many years of injudicious diet may pass without any pain being caused, till the stomach is finally damaged beyond repair, and the individual becomes the unhappy sufferer from chronic painful dyspepsia, "liver," or whatever his doctor chooses to call it.

Finally, no skeletal injury can occur without producing some effects on the visceral system, and *vice versâ*. But the effects of visceral on skeletal tissues is the more marked; witness the rapid wasting of muscles during even the briefest fever.

Just as we have seen in the relatively pain-producing skeletal system, injury may occur without pain, as in rickets, so conversely in the less sensitive visceral system pain of a severe character can be produced; the cause, however, is usually gross in character. The pain of biliary colic is caused by a gallstone, a sufficiently large stimulus when compared to the organ in which it forms—the gall bladder. Similarly the agony of renal colic. All forms of obstruction are associated with great pain caused by the attempts of the organ affected to rid itself of the damaging state of affairs. Such pain, unlike most skeletal pain, tends to increase rather than diminish, and if not alleviated causes death fairly rapidly. The mortality in such cases is due, not as in most other visceral diseases, to the absence of the "danger-signal" pain, but to the practical difficulty, absent in skeletal injuries, of getting at and removing the cause. And since abdominal surgery has advanced so wonderfully this practical difficulty is being overcome, and this essentially preventable class of visceral diseases shows a rapidly decreasing mortality. Here the value of pain is obvious enough. Sufficient has been said to show the broad differences as regards the value of pain in the various parts of the body; why conditions in which the time between reception of injury and the pain produced is short are most favourable; how microbic agents by their nature prolong this period, attack chiefly the viscera, and account for the greater mortality of visceral disease; and, lastly, how of all injuries those which give rise to no pain are worst of all. So far one has presumed that the third and fourth factors necessary for the perception of pain, namely, the nerves and the brain, were themselves intact. But one or both may be the seat of injury and so modify the phenomena of pain. Paralysis is often associated with complete anæsthesia, due to the damage of the nerves. Pain in the parts supplied by these nerves cannot be felt. Consequently we find extensive injuries, such as abscess, occurring unknown to the patient, injuries which, had the nerves been healthy, would never have reached their extent because of the pain they would have caused in their earlier stages. The brain may in certain conditions influence the perception of pain. Considerable differences occur in individuals in regard to their capacity not only for bearing, but feeling pain. Excitement, as in battle, may prevent pain being felt at all. It is well known that certain forms of madness are associated with extraordinary abnormalities in the capacity for feeling pain, and hysteria even is associated with defects of pain-perception. The whole question of the psychology of pain is interesting, but cannot be entered into here.

Man's relation to pain seems to show that under modern conditions his protective mechanism against microbic invasion has not reached that stage of perfection to which we are accustomed in Nature to look.

That this should be so is natural when we consider that man's whole mechanism is identical to-day with what it was in the prehistoric ages, and that this mechanism, once sufficient for all man's needs, is now constantly called upon to undertake duties and activities out of all proportion to its natural capacities. Can we wonder, then, that its protective functions have been unable to adapt themselves at an equal rate to these sudden changes? How long it will be before the "disharmony" (to quote a favourite word of Metchnikoff) between man and his surroundings disappears

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it is as yet impossible to say. Two courses are open whereby rebel man can be brought into line with Nature's methods. Either in the course of ages man will become gradually immune to bacterial disease, that is to say, he will go through the same old "survival of the fittest" ordeal which in regard to physical pain, as we have seen, he has successfully come through, or—and surely this is the less painful, shorter, and wiser course—man's intelligence will be directed to the prophylactic or preventive side of bacterial disease, and his activities directed into spheres less dangerous to his welfare.

Man by his brains has reduced the causes of "skeletal" injury to a minimum; equally is it possible for him to reduce "visceral" injury, thereby diminishing mortality, and enlarging his destiny.

FOR once the bacteriologists and hygienists, who usually appear to delight in alarming timid folk, announce a discovery which will reassure those persons who are afraid to eat green vegetables. Manau thought that he had discovered soil microbes in the interior of vegetable stalks. From this discovery resulted the condemnation of sewage farms and, indeed, of all market gardening as it is ordinarily practised, with the employment of manure. Fortunately this opinion has not been shared by all bacteriologists. In order to solve this problem, which is so important from the hygienic point of view, Remlinger and Nouri have undertaken a series of experiments, in which they endeavoured, by every possible means, to infect plants with microbes. In every case, however, they found it impossible to obtain colonies of microbes from the interior parts of the plants thus infected. Hence they conclude that the microbes in the soil do not penetrate into the interior of plants, but remain entirely upon the surface.

A Rainbow Photograph.

By ALLAN PHILLIP.

A RAINBOW in itself is so common a phenomenon that it calls for no special comment; but there are few natural phenomena which present such difficulties to photography.

It is this which leads me to believe that the accompanying photograph may be of some interest.

I claim no merit in the production of this picture; circumstances favoured me, hence the result.

I was on the summit of Castle Crag in the vale of Borrowdale when a thick mist suddenly came over the neighbouring hills and enveloped me. The sun gleaming through this mist "painted" a rainbow of exceptional brilliance on the screen of thin cloud below. The bow stood out the brighter because the background was dark in the shadows of the clouds.

A Photograph of a Rainbow.

The exposure was only $\frac{1}{20}$ second, and I used a Barnet ortho. plate, backed, but without the yellow screen. The plate was developed with pyro-soda very dilute, development taking nearly 20 minutes to complete.

I have not retouched the negative in any way. On the photo Lake Derwentwater is seen in the distance; and the coach road stands out white as it winds along the valley.

The Bowder Stone is also visible near the right-hand lower corner of the scene.

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Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Bleaching-out Process. At a recent meeting of the Royal Photographic Society, Dr. J. H. Smith gave an account of his investigations in connection with this process. It will be remembered that about three years ago his firm in Zurich introduced the "Uto" paper, which when exposed under a coloured transparency would give a print in colours that were surprisingly good imitations of the original. The film contained three dyes of a fugitive character; these were made still more readily bleachable by the action of light by means of anethole which acted as a sensitiser, and the anethole was afterwards removed as far as possible by a suitable solvent in order that the resulting print might be as stable as possible. The method depends on the fundamental principle that the light that causes any change, in this case bleaching the dye, must be absorbed. Therefore light that is not absorbed is without action. So red light, for example, being absorbed by green and blue dyes, has the opportunity of bleaching them, while as it is reflected by a red dye it has not the chance of acting on it, and therefore, if suitably arranged, the red is the only dye that survives under the red light. Light of other colours acts in a similar manner, and in this way the original colours are reproduced.

The difficulties that have to be overcome before such a process becomes of practical use are many and great. The three colours must be of the correct tints, and they must be unstable when exposed to light. But as the action of light is of a general kind, there is no particular reason why if it does act upon a substance it should so change it that the product of the change is white. The resulting substance may be darker than the original, or it may be of a different colour, but obviously for such a process one is limited to those dyes that give white substances when acted on by light. The dye when bleached is not removed as superficial observers appear to think, it is necessary therefore that the white product of the change shall be as stable as possible. But the bleaching action of light upon any suitable dyes is so slow that it is desirable if not necessary to urge on the change by adding a sensitiser, and this sensitiser must be removable when it has done its work, in order that the unchanged dyes that remain, as well as the white substances that result from their bleaching, may be tolerably stable when the print is finished. Even this is not all, for clearly the three dyes must bleach at the same rate or all compound colours, and almost all colours in nature are compound, will be tinted with an excess of the most stable constituent. This last condition Dr. Smith appears to have found specially difficult to realize, and he proposes to meet the case by putting a coloured glass over the printing frame during the exposure, that will hold back to the necessary extent the light that acts on the unduly sensitive dye or dyes.

The sensitiser used in the "Uto" paper was anethole, and it could not be completely removed. The examples that Dr. Smith recently showed, although probably three years old, had still a very marked odour of it. He is now using a quite different sensitiser, and one that is soluble in water. Presumably it is no secret, but as Dr. Smith was unwilling to say what it is, it is not for me to suggest what it might be. The new paper, which it is hoped will shortly be on the market, will, it is stated, be much more sensitive than the original "Uto," and will give the finer shades of colour more satisfactorily. It is hoped that it may be suitable for getting coloured prints from autochromes and other screen-plate colour photographs. But however successful the paper may be, it must be borne in mind that an initial want of stability is the principle upon which its very existence depends. The prints produced on it must be kept from the light as much as possible, and even with every precaution they must not be regarded as permanent, though with care they may outlive many a silver print.

Velvet Linings for Cameras. I have on previous occasions recommended black velvet as a lining for cameras that will permit of its use, such as non-folding hand cameras, and I refer to the matter again because one of its chief advantages has lately been urged as a reason for avoiding it. Of all practicable surfaces it is the one that reflects the least light, especially if it is brushed towards the lens, so that the pile is inclined towards the source of light. This is its first advantage. Its second advantage is almost as important, namely, that it catches dust. It was this circumstance that led to its condemnation. Of course it cannot catch any dust that is not already inside the camera, and the catching of such dust is very desirable. It used to be recommended for this purpose, to wipe over the inside of the camera with glycerine, when going into dry and dusty countries. This was a messy business though probably effective. It is astonishing how much dust does get inside a camera even in this country, and although it may be used for only a month or so in the year. If a dust trap of any kind is used, the dust must be periodically removed, and for cleaning velvet, a hogs-hair brush, such as artists use for oil painting, is very convenient, if chosen of a suitable size. I advocate the use of velvet after experience, having used a velvet-lined camera for many years. Mere inspection shows whether the velvet needs cleaning.

Plate Sensitiveness. It is a debatable point as to whether we are better off now than we were twenty years ago in the matter of the descriptions of the sensitiveness of plates that are given by the majority of makers. We know more about the subject, but this is not an unmitigated advantage from the user's point of view, for it has led to a multiplicity of systems and no-systems. The diaphragms of lenses and the speeds of good shutters are generally arranged so that each gives double the light effect or exposure of the one below it. Unless a plate is twice as sensitive as the one in use it will not permit of the next smaller diaphragm, or the next higher speed of the shutter; therefore any increase of sensitiveness less than this is of little use to the general worker. Of course a smaller rise of sensitiveness will tend to improve the negatives if under exposure has been the rule, but that is a different and generally an insignificant matter. It is unfortunate that high figures are often used, as they mislead those who do not give thought to the subject. There are no more degrees of sensitiveness between two plates that are expressed by the figures 200 and 300, than if they were expressed by the figures 20 and 30 or 2 and 3, and to employ one hundred degrees in the first case and only ten in the second has no justification in either theory or practice. As a matter of fact the ordinary photographer does not want any degrees between such a pair of figures, when the figures are proportional to the sensitiveness.

XUM

Classification and Mathematics.

By C. ELLIOTT.

TAKING any classified collection, for example one of butterflies, it will be clear that we can make a classification exactly resembling it, so far as the type of classification is concerned, from things which can be made to differ artificially in various respects, such as colour, markings, size, shape, the nature of these respects being a matter of indifference.

For example, pieces of cardboard may be coloured, and shaped, and marked, to form the classification which is to be the model of the other. The model differs from the original in that its members have not been collected and sorted, and in that they may differ from each other in respects which do not appear in the original, while also the members of the original may show many differences which do not appear in the model.

The model resembles the original merely in having the same number of chief classes, and the same system of subdivision of classes.

If our object is to make a comparative study of classifications, in short to classify classifications, it will evidently be better to pay attention to models than to originals, because in dealing with the originals the attention is likely to be distracted from the bare question of type of classification by the numerous differences which are not used in the classification at all. And, since the respects in which the members of a model differ from each other can be arbitrarily chosen, we can improve on Nature by making models which have no originals, that is we can use models to assist the imagination in inventing classifications.

Now, an examination of current scientific literature might suggest that, while works on the classification of particular things, such as butterflies or plants, are abundant, works on the science of classification itself must either be singularly scarce, or be masked under names which would not reveal their contents except to an expert.

The correctness of the latter supposition is partly due to the fact that philosophers have paid attention to classification from the earliest times, and a traditional complicated nomenclature of the subject has grown up. But their objects in so doing were so much more than the modest aim of making a careful comparative study of classifications, that this initial study has perhaps even at the present day hardly had the attention it deserves. It is contended here that a more important explanation of this apparent neglect of the study is that some of the results which already exist pass under the name of mathematics.

Between this view and the more common one which regards mathematical science as consisting of symbolic logic there is no real conflict. It is with the former, and, as I think, more readily intelligible view, however, that the present paper is concerned.

Perhaps the real meaning of both views might be pictured to the mind by supposing two men of great intelligence, but ignorant of ordinary geometry and algebra, shut up in two rooms with writing materials, and required in the one case to make a comparative study of all modes of reasoning known to him, in the other to make a comparative study of classifications by means of models, the materials for which we will suppose to be supplied. Now it may indeed be true that both men would in time evolve systems indistinguishable from elementary mathematics, but I venture to think that the man with the models would stand a far better chance of doing so than the logician. That either investigator would produce mathematical theories in the order in which they have been evolved historically seems highly doubtful.

We will suppose that the man with the models finds his attention early drawn to the existence of the kind of classification known as "classification and cross-classification." For unless this happens to be the case he will not make much progress, at any rate not in the direction of ordinary mathematics. Suppose then that he invents a name "duplex" for that kind of classification, "triplex" for one of three differentiations, any two of which have the relation of classification and cross-classification, and "quadruplex" for a similar one of four differentiations.

We will assume the reader's agreement with the statement that our investigator has now been fitted out with the mental tools necessary for studying "spaces" of two, three, and four dimensions, provided that the classes of any differentiation have a definite order, a matter considered below. For in order that classified things may form the points of a discontinuous plane it is not sufficient that they should be classified as a duplex, but also the classes of both differentiations of the duplex must have a definite order.

Now some of the points of a space may have other properties than those used in the classification, and may form a different space if attention is paid to these extra properties, so that there are two cases to consider.

Firstly, the two spaces may have the same number of dimensions, for example we might consider two duplex spaces of the same points. Secondly, one of the spaces may have more dimensions than the other, and this requires the introduction of terms like line, surface, which refer to the space of smaller number of dimensions. Thus for example the points of a line in a plane can be classified both as a single order, that is, as a one-dimensional space, and as the points of an ordered duplex.

Such words as "point," "line," "straight line," "parallel," "triangle," and so forth belong to the terminology of classification just as much as the words genus, species, variety, and their introduction would be suggested by a comparison of models of classifications. The teacher who begins geometry with Euclid does in reality first construct in a particular way, or suppose to be constructed, a duplex of points of ordinary space, to which he then applies the nomenclature and reasoning of the science of classification. The part played by the metre rule and set square is solely that of constructing a particular ordered duplex of points of ordinary space, or a portion of one, such as a triangle. Their use and that of other geometrical instruments may be compared with the use of paint and scissors when a number of pieces of cardboard are formed into a colour-shape duplex, or a portion of one. It is a mistake to suppose that we ever really compare two distances except by counting the number of point intervals in each, and geometrical theorems, such as the theorem of Pythagoras, are not solely valid for a particular duplex of points of ordinary space, but hold equally for any ordered duplex of any points.

It seems likely that a person whose geometrical ideas were derived from the study of classifications rather than from that of the motions of solids would find a small difficulty in understanding the notion of fractional distances, an idea dealt with below, and much more difficulty in the case of irrational distances. For the distances which he would presumably consider first would be expressible only by whole numbers. But it must be remembered that, according to a general opinion, such difficulties are rather obscured or ignored than overcome in most existing methods of teaching.

XUM

To return to our supposed investigator, it will be asked to what province of arithmetic or algebra would his study of models be likely to lead him first. And I conceive that the answer to this is the theory of Groups. For in order that there may be a one-to-one correspondence it is necessary that the things which correspond should be classified and cross-classified.

Thus, for example, the correspondence tabulated in an English-French dictionary arises through the words being first of all classified as English and French, and then cross-classified by meaning.

The words correspondence, function, operation, dependence all truly relate to this one idea of classification of things into two classes or "quantities" and their cross-classification. And if it is desired to make a model of, say, a correspondence of colours to shapes, we must first of all arrange that things having the desired colours fall into one class, and those having the desired shapes in another class, the precise way in which this is done being a matter of indifference. Then we must arrange for each thing in the one class to agree in some respect with a thing of the other class—that is, we must make the members of the model so that there is a cross-classification. The functions considered in the theory of Groups differ from such a correspondence merely in the circumstance that the same operands (instead of different ones as above) appear in both quantities.

Thus a model of a function of this kind can be made in the same way as the model described above, the simplest example being the case where each operand of one quantity corresponds to the same operand in the other, which is the function "one." The convenience of introducing such names as direct, inverse, product, quotient, power, root, would, I think, appear when attention was paid to functions having a quantity in common. For two quantities which correspond to the same quantity correspond to each other; and their correspondence to each other is called the product of the correspondence of one to the intermediate quantity and of the intermediate quantity to the other. In passing one may, however, notice that there are some regrettable exceptions to this rule of nomenclature. For example, it is usual to call the true product of two vectors their sum.

It will be remembered that, in speaking of elementary geometry, the question of the meaning of order was postponed. Now, following B. Russell's "Principles of Mathematics," it appears that the necessary condition for things having a fixed recognisable order is that they should be the operands of some function of the kind under consideration. Taking any one operand, we can count from it in two senses or directions, the operands on one side being "direct" powers of it and those on the other side "inverse" powers of it.

So that in a sense one may say that the idea of "distance" in geometry is the same as that of "power" in lagebra.

If the same operands with others appear in another such function they may or may not be given the same order. Suppose that their order is the same, and that one of the new operands comes between any two of the old. Then the distance from a new to an old is half the distance from an old to an old.

It is the circumstance that the same operands may appear in several functions, which thus insert new operands into their order, that requires the introduction of halves and other fractional distances.

To describe in detail the subsequent developments which might be expected to follow from the study of models of classifications would occupy too much space and perhaps be of doubtful value. Since the properties of any correspondence can be studied by means of models it follows that one might expect the study of the correspondence of operands to functions, and of functions to functions, to follow on that of operands to operands. And a consideration of models, or of tables of symbols, representing the correspondence of operands to functions, would, I think, suggest investigation of the so-called permutative, associative, and distributive laws.

Solar Disturbances During February, 1910.

By FRANK C. DENNETT.

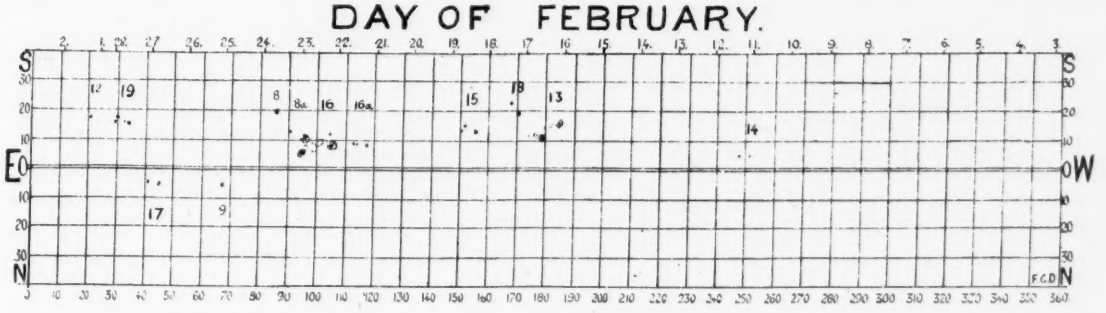
DURING February there was a very decided falling off in the number of spot outbreaks, although two were of considerable extent. On the 4th, 8th, and 9th only faculic disturbances were seen, whilst on 7th neither bright nor dark spots were visible. The longitude of the central meridian at noon on February 1 was 23° 52′.

Nos. 8, 8*a*, 9, and 12 remained on the disc at the beginning of February, and so are shown on the present chart.

No. 13.—At first, on 10th, there were two small spots, and on 11th pores began to show as well. Both spots reached a considerable diameter, the leader being somewhat the larger, and quite 22,000 miles across. On 16th the eastern spot had a curved attachment of penumbra eastward, which increased its diameter to 27,000 miles. The length of the disturbance, on 15th, was 81,000 miles. The group dwindled somewhat after 17th, but was still visible just within the limb on 22nd. The inner edge of the penumbra of the eastern spot was noticed to be bright fringed on 20th and 21st.

No. 14.—Two pores, the leader smaller, seen 13-14th, about 23,000 miles apart. The larger was still visible on 15th at the rear of a faculic disturbance. The facula remained until 16th.

No. 15.—At 10 a.m. on 15th a faculic disturbance was seen containing a single pore. By 2 p.m. there were three. Next day a triangle of spotlets 50,000 miles in



length were observed, the two eastern ones being replaced by three pores on 17th, and a curved trail 18th. One or two points were visible until 20th, but the leader was seen until 23rd.

No. 16.—Seen on 17th as a small spot, but on 18th there was a faculic disturbance containing four. The number continually increased, but the members were small until near the central meridian. The group was triangular in form, the apex being westward. At each angle a large spot formed, the leader having a maximum diameter of 27,000 miles, and the group a length of 105,000 miles, making its area nearly 4,000,000,000 square miles, visible to the naked eye. It was last seen when passing round the limb on March 1st. The south-eastern angle overlapped the area of No. 8*a*. Projected prominences were visible with the spectroscope amid the group, and the dark line of helium—D_3—was readily visible on 23rd deflected to red.

No. 16*a*.—At 8.40 a.m. on 23rd the spectroscope showed intense activity present just ahead of 16, where the new group *a* of three spotlets had broken through. It was 35,000 miles in length, and remained visible only until 26th, although there were still bright faculæ there on 27th.

No. 17.—Two spots were seen close within the eastern limb on 21st, but afterwards, 22nd to 27th, only one, which died out just after crossing the central meridian on the later date.

No. 18.—Two little spots in the rear of No. 13, but in more southern latitude, only seen on 21st.

No. 19.—A group of about half-a-dozen pores, in triangular form, about 36,000 miles in length, on February 27th. On March 1st only two, and when last observed, on 2nd, a solitary pore seen.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

CORRESPONDENCE.

A New Suggestion Regarding the Tails of Comets.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—It is, I think, pretty generally assumed that the tail effects of comets are to a great extent electrical, nor do I think that it can be doubted that great electric action is taking place in the sun.

Now, if a conducting body be moved from a position where the electric potential is low to one where it is high, electric effects are produced in that body; whereas if the body be moved in or nearly in the locus of an equipotential surface, its electric condition will suffer little or no disturbance. A comet moving in a long ellipse or in a hyperbola comes from far off space at low potential to the neighbourhood of the sun assumed at a high potential, and again recedes at extreme velocity; hence violent electric effects may be expected; while a planet, as the earth, remaining at approximately a constant distance from the sun, and therefore upon an equipotential surface, or nearly so, shows but little of such phenomena.

Next, I would suggest that all space, at least anywhere near the solar system, is filled with a gaseous compound of carbon at very low pressure, say, .01 millimetre.

This would not appreciably retard the planets in their orbits, although it might affect a comet, as is apparently the case with Encke's.

If this is the case, a comet under the strong electric induction produced by its great change of potential will throw off into this rare gas luminous waves of electricity, and thus exhibit a tail not really part of itself, but the effect of itself upon surrounding space.

As the comet rounds the sun, different regions of space will receive the electric flow, and since these regions of space are probably not all filled with the same rare gas, and at the same density, there will be curves, knots, and deviations in the tail such as are recorded. Its spectrum will show the lines of the rare gas of space—*vide* the experiments of Fowler and Payne on the carbon spectrum of the Morehouse comet (Monthly Notices of the R.A.S., December, 1909), while nearer the head solar light will be reflected from the clusters of discrete particles, which are probably there.

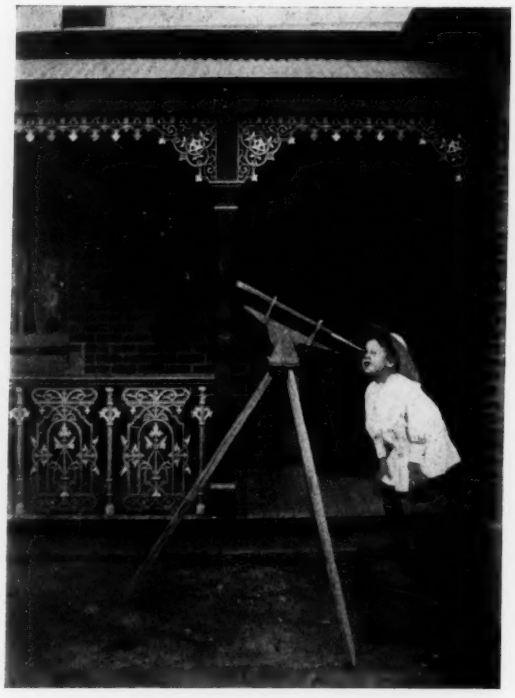
Stars will be seen through the tail, as they are, and also through the head, if it is composed of discrete particles moving with great velocity; the time occupied by the several eclipses of the star by the moving particles being infinitesimally small.

Lastly, may not the planets have obtained their carbon—the basis of all organic bodies—by a sort of segregation from this carbon-laden space, even as diatoms and sponges have obtained their silica from sea water? The latter contains but an inappreciable amount of silica, yet these bodies get possession of it. Space may contain an infinitesimal amount of carbon, yet we find abundance of it, possibly from this source, upon the surface of our planet.

F. B. ALLISON, M.A., F.R.A.S.

Peasmarsh, Sussex,
March 11, 1910.

SIRS,—Enclosed is a photograph of a pine tripod stand for a portable telescope on, I think, a new principle, which may be of interest to your readers. It was designed and made by a friend of mine, and has the advantage of being light and rigid. The wooden uprights which support the telescope are removable, each being pierced with a hole, the



centre of which coincides with the axis of the instrument, and at the top of these I have fixed sights to act as finder. The photograph also shows the handiness of an apple-case which the youthful student is standing on. For an adult this forms a convenient seat and as it can be placed in three ways does for most altitudes of the telescope, so that one can observe in comfort.

Yours, etc.,
BERNARD THOMAS, M.B., C.M.

Lovett, Tasmania,
January 29, 1910.

The Evolution of the Bull Dog.

SIRS,—In an interesting article with the above title in "KNOWLEDGE" for this month, Mr. Pycraft traces the descent of the modern bull dog from a small breed of mastiffs used for hunting wild cattle, and, later on, for bull-baiting. There appears to be little record of the stages of this evolution; and it may therefore be of interest to your readers to see from an old picture what the ancestors of the present monstrosity were like. I enclose a photograph of an engraving in the possession of Miss Dawson, of Clifton, in which the strong, muscular frame, and the longer snout seem to show a near kinship to the mastiff. The engraving

is certainly an old one, but unfortunately bears no inscription of any kind, and no clue to the name of the artist.

In that ancient book, "The Master of Game," written by Gaston de Frix, and copied, with modifications, by Edward, second Duke of York, there is mention of bull-baiting by the inferior varieties of a dog called the *alaunt*, which possessed apparently great tenacity of "hold," a short head, and other characteristics which suggest the possibility of our bull dog being derived from this stock. In the appendix to the Messrs. Baillie-Grohman's edition of this book it is stated that the *alaunt* was brought originally from Spain, "where dogs used for bull or bear baiting are still called 'alanos.'"

Yours, etc., G. MUNRO SMITH.

Clifton, *March* 20.

Mars.

SIRS,—Mr. Maunder's article in the March number of "KNOWLEDGE" is a valuable corrective to the exaggerated statements about Martian discoveries so often seen in the daily Press; and his views on the subjective explanation of Schiaparelli's, Lowell's, and other observations must necessarily carry much weight in the astronomical world; if Mr. Maunder is right the artificial irrigation theory necessarily falls to the ground with the assumed evidence for it; future observations must be left to settle this issue.

Meanwhile it seems hardly worth while to put forth *a priori* arguments against the theory, dependent upon our supposed knowledge of the physical condition of the planet. For instance, the temperature of the planet's surface, whether we consider the mean or the range, can hardly be treated as a matter of a rule-of-three sum with that of the Earth. Arrhenius has arrived at the following remarkable and significant result in the case of our Earth: If the very small quantity (3 parts in 10,000) of carbon dioxide in our atmosphere was removed, the mean temperature of the earth would be lowered by no less than 21° Cent., owing to high selective effect on radiation of the small quantity of this gas in our atmosphere. Now it can hardly be maintained that we have any precise measurements of the quantity of carbon dioxide, aqueous vapour, or other gases that may exist in the atmosphere of Mars; and it is as likely as not that the temperature on the planet may be much less unfavourable to life than would appear from Mr. Maunder's conclusions.

It is perhaps unnecessary to criticise Mr. Maunder's remark as to "the small effectiveness of an ordinary pump in so rare an atmosphere" as that of Mars—a *suction* pump is not the only method of raising water, and the small force of gravity at Mars' surface is surely in favour of the hypothetical Martian engineer.

It will be time to discuss the impossibility of artificial origin if and when the final verdict of the observations leaves us with a "canal" network which we cannot believe to have arisen by natural causes; till then it seems a pity to prejudice the real issue (viz., do present observations correspond with an actuality on the surface of Mars?) by introducing arguments based on such uncertain data as our knowledge of the physical state of the planet.

Yours, etc.,
ARNOLD G. HANSARD, B.A., M.I.E.E.

Limpsfield, Surrey,
March 18.

Astronomical Superstitions.

SIRS,—I was much amused by the three letters which you published in the January number of "KNOWLEDGE" from Messrs. (Rev.) Joseph W. Brady, S.T.L., J. A. Hardcastle, and Charles C. Conroy, A.M., M.S., and am glad, indeed, that you inserted them.

I think the reproduction of such letters, occasionally, is most instructive, if only for the lesson they teach—that even in the twentieth century superstition and intolerance are still rampant in widely-separated portions of the so-called "civilised" globe.

The article from the *Popular Science Monthly* was, in my humble opinion, most interesting, accurate, and harmless, and the inclusion of it in your columns well advised. I may say that the *Popular Science Monthly* is one of the most widely-read magazines of its kind on this continent, many prominent living men of science contributing to its pages.

I hope, in the interests of the large majority of your readers, that you will not allow yourselves to be in any way influenced by the three hysterical letters referred to above, but will continue to publish, fearlessly, in your excellent magazine the latest results in the search after truth, and so keep your readers up to date. (Rev.) Joseph W. Brady's veiled threat to discontinue his subscription is a serious one for you, but I really do not believe that even such drastic action on his part would have the result of suppressing "KNOWLEDGE" altogether. I would suggest that this gentleman read once more the life of Galileo; his present knowledge of the facts concerning that unfortunate individual is seriously at fault.

I would like Mr. Hardcastle to explain how emotion can have anything to do with the attainment of truth, as he appears to suggest in the last paragraph of his letter. Such an explanation would, I feel sure, be most welcome to many of your readers.

As regards Mr. Charles C. Conroy, A.M., M.S., I do not think he should read "KNOWLEDGE" at all. He lacks, entirely, that calmness of mind which is so essential in the discussion of scientific problems.

You are at liberty to publish this letter if you wish. I wrote it because we suffer from similar examples of hysteria in this city, but, in the interests of truth and fair play, we never allow them to pass unanswered. Wishing you every success,

Yours, etc.,
A. H. W. CLEAVE.

Rideau Club,
Ottawa, Canada.

Answer to Correspondent.

E. J. Foden.—The lunar photograph you enclose is so much out of focus that all the details of the terminator are lost. You should endeavour to improve the definition, either by more careful focussing, or, if this is correct, interpose a colour screen to minimise the effect of chromatic aberration of the objective.

XUM

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

RADIAL VELOCITY OF PROCYON.—W. W. Campbell announces that at the Lick Observatory they have now spectrograms of Procyon showing the radial velocities as determined by the Mills spectrograph, extending over the past thirteen years, this being one-third of the revolution period deduced by Auwers. From the discussion of these it appears that the radial velocities have not appreciably altered, and are therefore in agreement with Auwers' conclusion that the orbit plane of the Procyon system is approximately tangent to the celestial sphere. The Lick observations do give some indications of a secondary period of about 7 years, with double amplitude about 1.5 km., but further observations are necessary to confirm this.—(*Lick Observatory Bulletin*, No. 173.)

OBSERVATIONS OF COMET 1910a.—Observers in America have been very fortunate in their opportunities of working on this comet. At the Lick Observatory it was easily picked up on January 18, having the appearance of a fan-shaped cloud a few degrees east of the sun. When at its best it was several times brighter than Venus. Numerous photographs were taken with the Crocker and Crossley telescopes. In a single 60° prism spectroscope the spectrum of the nucleus appeared as a bright continuous streak; compared with the sky the spectrum of the comet was relatively stronger in the region of greater wave lengths. In the yellow region the D lines of sodium were so brilliant that an attempt was made to photograph them with a powerful grating spectrograph. On January 27, with an exposure of 51 minutes, both sodium lines were recorded, and the resultant radial velocity + 66.1 km. A small portion of this may be due to the ejection of sodium vapour from the nucleus.

M. H. Deslandres announces several very important results obtained with a slit spectrograph, from which more precise wave-lengths could be deduced than was possible on the prismatic camera plates. The objective is 10cm. aperture, 80cm. focal length, giving an image of the comet on the slit of the collimator of 0.30m. focal length. The camera lens used was of 0.12m. focal length. The best photograph was taken on January 29 with an exposure of 45 minutes. The comet spectrum extends from λ 380 to λ 500, and a comparison spectrum of the spark of iron is on the same plate. The nucleus showed a continuous spectrum with strong condensations. Their positions are λ 4737·5, 4716.5, 4686.5, 438-435, 4366.5, 4317. 4307.5, 4216, 4196.5, 4123, 4084.0, 4021.0, 3883.0, 3867.5 These indicate that the spectrum was chiefly due to hydrocarbons and cyanogen. It is noteworthy that the relative intensities of the various bands do not agree with the corresponding terrestrial intensities; in the comet the most intense bands are those near the more refrangible or blue end, while in the spectrum of the electric arc or the bunsen burner the intense bands are in the green. —(*Comptes Rendus*, No. 150, pp. 653, 655, March, 1910.)

DISPERSION OF LIGHT IN SPACE.—The work of M. Tikhoff, which was claimed to prove the fact of dispersion in space has given rise to many criticisms of the method employed, chiefly in the direction of showing that the results obtained may be explained in another way. J. A. Parkhurst has shown that there are various photographic phenomena to be allowed for in dealing with the estimations of stellar magnitudes from plates. More recently H. E. Ives calls special attention to the fact that the scale of gradation may be very different for different colours, as first suggested by Eder and Abney. Two facts have been observed by Ives which appear to have a close bearing on the question, viz., (1) with certain developers and plates an image taken through a red glass develops more slowly than one through a blue glass, although the final density may be the same; (2) in a plate sensitised by bathing the sensitive layer is very thin. These effects were observed whether the tests were made with constant light source and variable exposures, or with constant exposure times and variable light intensities. These facts appear to prove that the relative photographic action of different colours is different for different exposures and for different absolute intensities. They show that it is at least necessary to investigate such phenomena thoroughly for all plates used in stellar photometry before any deductions are made from the results. It is understood that the plates used by Tikhoff were bathed, so that his results were exactly of the nature here considered.—(*Astrophysical Journal*, Vol. 31, p. 157, March, 1910.)

DISPLACEMENTS OF LINES AT THE SUN'S LIMB.—When spectrograms of the solar surface taken with large dispersion are closely examined it is found that certain groups of lines show different displacements, these differences being independent of those produced by the axial rotation of the sun. Halm drew attention to the phenomenon in 1907, suggesting that they might be due to the somewhat greater effective pressure in the sun's reversing layer at the limb than at the centre, the lowest strata contributing a relatively greater length of path to the light at the limb. In the same way Halm explained the absence of displacement of an enhanced line at 6516 by the fact of its being a high-level line. A detailed examination of such phenomena was undertaken by Hale and Adams with the 18-feet spectrograph of the Mount Wilson Observatory, and W. S. Adams now gives a long discussion of the results obtained by further work with the more powerful 30-feet spectrograph. A working list of 470 lines was selected for special study, these being divided into seven types. A list of displacements is given for these, and from the discussion of the table it is seen that the lines of hydrogen, H and K of calcium, D lines of sodium, and *b* lines of magnesium, show no appreciable displacement. The other lines of calcium, sodium and magnesium, do show movements. The displacements of titanium, vanadium, and scandium are considerably smaller than for iron and nickel. Generally the lines of elements of high atomic weight, such as lanthanum and cerium, show small displacements. One or two special lines are shifted towards the violet, *e.g.*, the titanium line at 4527.490. The lines strengthened at the limb show small displacements. The enhanced lines as a class show decidedly larger shifts than the arc lines, especially in the more refrangible portion of the spectrum, the iron lines giving the largest of any in the whole list. It is possible that these lines may be due to sudden uprushes of gas giving similar conditions to those found in spark spectra, showing the enhanced line condition. The displacements in general appear to increase towards the red end of the spectrum, and the probability of the phenomenon being due to pressure effects is considered at length.—(*Astrophysical Journal*, Vol. 31, p. 30, January, 1910.)

BOTANY.

By G. MASSEE.

DIE-BACK OF HEVEA BRASILIENSIS.—Mr. T. Petch has given an account, in Circular No. 23, Royal Botanic Gardens, Ceylon, of a serious disease of the rubber-producing tree *Hevea brasiliensis*, which is cultivated very extensively in Ceylon. As implied by the name, this disease kills back the tree from the top. When first observed it was essentially a disease which attacked young trees from one to two years old. Recently, however, it has assumed a more serious aspect, attacking trees from nine to fourteen years old, and in some cases it has killed these with astonishing rapidity. The fungus which originates the disease attacks the leading green shoot. The place attacked becomes dark-brown, and this coloration gradually extends over the whole shoot; the leaves fall off as the fungus reaches them. The brown diseased patch is frequently rather soft, but hardens and turns grey. Infection occurs some distance from the tip of the shoot, the brown discoloration extending upwards and downwards. The fungus causing this disease, *Glœosporium alborubrum*, produces its fruit underneath the epidermis or skin of the dead shoot, and when the spores

are ripe the epidermis is ruptured, which makes the shoot rough to the touch.

If the dead top shoot is cut off, the tree sends up a new leader and the disease is thus got rid of with very little damage to the plant. If this precaution is neglected the "die-back" may extend downwards until it reaches the root, and the tree is killed outright. The disease is complicated by the advent of a second fungus, which first attacks the portion killed by the *Glœosporium*, and afterwards attacks the living stem, gradually killing the stem down to the ground. The second fungus is called *Lasiodiplodia theobromæ* (=*Diplodia cacaoicola*), a well-known and destructive parasite on the cocoa tree, sugar cane, etc. If the diseased terminal shoot is removed before the second fungus gains a foothold, but little injury is done. On the other hand, if the disease has passed beyond this stage the top of the tree should be cut off below the dead part, and the wound dressed with coal tar. As both fungi can live on dead leaves, wood, and stumps of Hevea, all such should be removed and burned.

NEW METHODS OF PLANT-BREEDING.—Plant-breeding, or the production of new varieties, which are in some measure improvements over the old ones, is gradually becoming an important factor in the culture of plants. Until quite recently it has been impracticable for others than experts to cross many plants owing to the fragile nature of the sexual organs. This difficulty has now been removed by Mr. G. W. Oliver, who has described in detail in *Bulletin* No. 167, U.S. Department of Agriculture, a method by which cross-fertilisation can be effected with certainty. The contribution does not deal with laws, but with practical methods for accomplishing what have hitherto been considered impossible or difficult crosses. The new method, termed depollination, is the removal of pollen from the stigma before fecundation has taken place. It is applicable to flowers in which emasculation is impracticable, because of the minuteness or delicacy of the floral organs, as in many species of composite plants, etc. The principal point is the removal of the pollen by means of a fine jet of water. The water is contained in an india-rubber bulb terminating in a neck, into which a piece of glass tubing drawn to a fine point is fixed. Through this fine opening a jet of water is forced by applying a slight pressure to the bulb. A few seconds suffices to remove all traces of pollen from the stigma.

For the removal of pollen which may have been deposited upon the stigma previous to pollinating, the depollinating process should always be used. If the pollen has been present on the stigma for only a short time it can be removed effectively. In a case of lettuce flowers, the pollen had been on the stigma for an hour and a half before depollination, yet a successful cross followed.

THE EFFECT OF CHEMICAL AGENTS UPON THE TRANSPIRATION AND GROWTH OF WHEAT SEEDLINGS.—Knowledge of primary importance from an economic standpoint has resulted from the investigations of various scientists bearing on the transpiration of plants. Such knowledge has been considerably extended by Dr. Howard S. Reed, who records in *Bot. Gazette* the results of a study of the effect of certain chemical compounds (mostly salts) upon the transpiration of wheat plants, in relation to the effect of the same compounds upon the growth of the plants. The studies were based upon the amount of water transpired per gram of green substance produced under different conditions of experimentation, a factor designated as "correlative transpiration."

Higher concentrations of the chemical agents were avoided, as a sufficiently concentrated solution of a non-toxic salt will retard growth and produce the effect of a "physiological drought." The small amounts of the respective chemical agents used had a definite influence upon the correlative transpiration. In the case of lime and sodium phosphate transpiration increased, but potassium salts decreased it; while sodium nitrate was somewhat variable, usually causing decreased transpiration. Potassium is more efficient than sodium in diminishing transpiration per unit of green growth produced. Inorganic acids retarded transpiration, while organic acids were somewhat variable,

POISONOUS PROPERTIES OF ENTOLOMA LIVIDUM.—*Entoloma lividum* (= *Agaricus lividus*), a large toad-stool not uncommon in this country, has long been suspected as possessing poisonous properties. This suspicion has been confirmed by Dr. Butignot, who reports in *Bull. Soc. Myc. France* that a family of five persons suffered very severely, though without fatal consequences, after partaking of four small specimens of the fungus. *Entoloma lividum* cannot possibly be mistaken for any recognised edible fungus, and it is considered that its pleasant smell of fresh meal tempts inexperienced persons to consider it as being wholesome.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

SYNTHETICAL PRODUCTION OF SAPPHIRES.—A new method of producing sapphires by fusion is described by M. A. Verneuil in the *Comptes Rendus*. A mixture of alumina with 1½ per cent. of magnetic oxide of iron and one-half per cent. of titanic oxide was fused by means of the oxy-hydrogen blow-pipe, and yielded sapphires, which had the same colour, structure, and optical characteristics as the natural stone. The presence of the titanic oxide appeared to be essential to the success of the process.

THE DANGERS OF FERRO-SILICON.—Allusion has already been made in these columns to the frequent accidents that have taken place during the last few years in the transport of ferro-silicon, owing to the evolution of poisonous or explosive gases. From the recently-published medical report of the Local Government Board it appears that in every instance the accidents have been traced to the "high-grade" ferro-silicon, produced in the electric furnace, and containing from 40 to 60 per cent. of silicon. These alloys invariably emit phosphuretted hydrogen, and, to a less extent, arseniuretted hydrogen, and the evolution of these poisonous gases is promoted by the presence of moisture. Moreover, the alloys of 50 per cent. grade have a special tendency to disintegrate spontaneously, and in such cases a greater proportion of gas will be given off. The low grades of ferro-silicon containing 10 to 15 per cent. of silicon, which are produced in the blast furnace, do not emit poisonous gases even in the presence of moisture, and hence do not appear to have been the cause of accidents.

Pending an international agreement on the subject it is suggested that the following precautionary measures should be taken to prevent accidents during the storage and transport of ferro-silicon. Before being sent out of the works the alloy should be broken into small pieces and stored for at least a month under cover, but exposed to the air as fully as possible. The percentage of silicon and date and place of manufacture should be plainly marked upon each barrel. The carriage of ferro-silicon on passenger vessels should be prohibited, and special precautions as to storage upon cargo steamers should be enforced. If possible, the cargo should always be placed on deck, or failing that the storage place should be adequately ventilated, and isolated by air-tight bulk-heads from the part of the vessel occupied by the crew. Similar regulations should also be enforced at the docks where ferro-silicon is stored or in the works where it is used. It is suggested as a counsel of perfection that the proprietors of iron and steel works might assist in the protection of their work-people by restricting their orders for the alloy to grades containing either less than 30 per cent. or over 70 per cent. of silicon.

Mr. R. Taussig, in an article in the *Times*, criticises some of the statements in the Local Government Report. He points out that technically pure ferro-silicon, containing only negligible traces of volatile phosphorus and arsenic compounds, is now manufactured in electric furnaces of sufficient power, and that there are on the market numerous grades of the alloy which have been stored for months without showing any signs of the emission of poisonous or explosive gases. The best test of the quality of a product is its behaviour on storage, and if it does not decompose when exposed for some time to moist air it is

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absolutely harmless to the workmen. Hundreds of tons of ferro-silicon, containing on the average 50 per cent. of silicon, have been sold which have fulfilled this requirement, and yet, if the report were adopted, these would be excluded from the market. The mode of manufacture is a far more important factor than the percentage of silicon. In the case of large furnaces the impurities (phosphorus and arsenic) pass, on smelting the materials, into the slag, so that the ferro-silicon undergoes a process of refining in the furnace itself. In the small furnaces, however, in which most of the ferro-silicon of commerce is prepared, this refining process does not take place.

COMPOSITION OF THE "FLORA" BUST.—The current issue of the *Chemiker Zeitung* contains an analysis by Dr. Pinkus of the wax composing the celebrated "Flora" bust, which Dr. Bode attributed to Leonardo da Vinci and purchased in London for the Berlin Museum for £9,250. This analysis shows that the material consists of a mixture of beeswax, shellac, and spermaceti, and if, as is asserted, spermaceti was not in use prior to 1700, the wax composition cannot be more than about 200 years old at the outside. Judging by ancient alchemical recipes, however, spermaceti was known in the 15th Century.

It is also pointed out by Dr. Pinkus that the wax used by Lucas for his wax figures contains the same proportion of spermaceti and shellac, and that this fact is strong evidence in support of the assertion that the real sculptor of the reputed Leonardo bust was Lucas.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

MICROSEISMIC OSCILLATIONS.—*Nature* has recently described the interesting results arrived at by the various committees appointed by the International Association of Seismology. Those referring to the slight movements of the soil known as microseismic oscillations attracted much attention. We find that two kinds of oscillation have been particularly noted, one having a short period of about half a minute, and the other having a period of between four and nine seconds. The short-period microseism appears to effect large portions of the earth's surface simultaneously, and it has been found beyond all doubt that there is a direct relationship between the amplitude of the oscillations and the period. They seem to follow in the track of a centre of low barometric pressure after that centre has passed away over the ocean. Weickert has suggested the impact of ocean waves on the shore may give rise to these oscillations, and thus the wave-beaten shore may pass on the energy which it is receiving at each shock as a wave breaks upon it. Further experiments are to be made to investigate the suggestion. It may be also that even as waves are set up at sea by wind intensity, the surface of the land is similarly affected, and microseismic wave-motion set up by local winds on shore.

THE GOLD-STONE.—The story of the re-discovery of the "Druidic Altar," locally known as the "Gold-Stone," now to be seen in Hove Park, Brighton, is interesting. This had stood from time immemorial in the valley known as Goldstone Bottom, which has its embouchure between Hove and Portslade, but it was carefully buried out of sight in 1833 in a pit which an unappreciative farmer caused to be specially dug to receive it. A veteran labourer was found in 1900, who had actually had a hand in the burying of the altar-stone 67 years earlier, and with his assistance and that of an old grave-digger, it was finally located, although only after a series of trial holes had been bored with a view to hit upon the stone. In Horsfield's "Sussex" (1835), an account was given of the stone, and it is there spoken of as "one of the largest and most remarkable of the Druidic stones upon the Downs." The measurements given by Horsfield are less, however, than those which have been disclosed now that the stone has been completely uncovered, and our illustrations show it to stand at least 8 feet high. It is about 11 feet long, and 5 feet thick. It consists of a conglomerate, with flints set in a siliceous cement. It no doubt is a remnant of a tertiary bed which once covered all the chalk, for a similarly-constituted bed still exists in the neighbourhood of Seaford. The Gold-Stone has a series of veins of spar running through it. As now set up, it is surrounded by ten smaller stones, seven of which are of a similar rock, whilst three are dark ferruginous iron-stones, with similar flints. No

doubt these formed part of the Druidic circle which formerly surrounded the Gold-Stone. The largest of the smaller stones measures 3 feet by 3 feet, with about the same thickness, whilst the smallest has about half the same cubic capacity. In that the stones are not now in their original positions, to this extent their value is lost, but they are near to the original site, and serve a useful purpose in their present position. The centre stone gives

its name to the neighbouring valley, and the Brighton and Hove Natural History Society deserve great credit for the disinterring of the stone.

It is perhaps interesting to note that the episode on which Tennyson founded his poem of "Rizpah" took place on the hill overlooking Goldstone Bottom. Here the two robbers of the mail suffered the penalty of hanging for their misdeeds, and here their mother collected their bones as they fell from the gallows.

DISCOVERY OF MOUSTERIAN MAN.—A whole skeleton of Mousterian man has at length been obtained, and a description has been given in *Nature* of February 24. It appears to have been buried in some rock-shelter, and the site afterwards used as a dwelling-place for Aurignacian man. Later, the chalk roof collapsed, and the writer of the article calculates that the remains have been embedded where they have been found for 20,000 years. The locality where the discovery has been made is at Ferrassie, in Dordogne, and five distinct age-layers have been examined. The lowest contains Acheulian material, and the next is Mousterian, the three upper layers representing the Lower, Middle, and Upper Aurignacian stages of man. The skeleton was found

between the first and second layers mentioned, and scattered around, and above and beneath were numbers of bones of the bison, deer, goats, and reindeer, with numerous artifacts of Lower Mousterian type. Examination of the skeleton is being made, and details will be awaited with interest. Dr. Capitan and M. Peyrony are to be congratulated on this further important discovery.

BRAUN'S MINERAL KINGDOM.—We have received a further instalment of Braun's Mineral Kingdom, a translation of which is now being issued in two-shilling parts by Messrs. Williams and Norgate. The translation is by Mr. L. J. Spencer, of the British Natural History Museum, with various additions by himself. The coloured reproductions of minerals are most praiseworthy. In Part IX. the uranium compounds are dealt with. The rays emitted by some of the constituents of pitch-blende or uraninite, we are told, cause the air to become a conductor of electricity, an electroscope being discharged by them. Extremely minute particles of the substance itself may possibly be projected from the main mass, and give the now well-known phenomena characterising the mineral and its constituents, radium and polonium. Rays emitted by radium cause diamonds to phosphoresce slightly in the dark, this not being appreciably the case with either glass or rock-crystal. There is doubt still if radium be an element; it may possibly prove to be a compound or a mixture. Pitch-blende may contain as much as 80 per cent. of uranium oxides. Radium is said to possess all the advantages of the Röntgen rays without their injurious effects, and in addition it is more easily applied in the treatment of cancer than by means of cumbersome electrical apparatus.

TIN-DISEASE.—In the same publication there is a remarkable illustration of a strip of metallic tin attacked by the "tin-pest." Tin is subject to a remarkable kind of alteration, a species of disease to which it is liable. Tin when exposed to the air undergoes no chemical change; iron and copper, of course, chemically combine with the oxygen, or with water. Tin, however, still remains metallic tin, but gradually becomes grey and dull, and falls to powder. The disease is "catching." It infects or induces the change in other masses of tin in the immediate neighbourhood. We are told that in a Russian imperial magazine, in place of tin uniform buttons, little heaps of powder were found. A consignment of Banka tin sent from Rotterdam to Moscow in 1877 arrived at the latter place in the form of powder. This alteration is due to a change in the internal crystalline structure of the metal, and is analogous to the slow transformation of monoclinic sulphur into rhombic sulphur. As a result, objects of tin of archæological interest are rare. Those that have been found have been in the form of earthenware vessels, nobs, etc., which have been found in the Swiss lake-dwellings coated with tin-foil. Cassiterite, or tinstone, is the single ore from which the tin has been obtained in any quantity. Cornwall is well known as a tin-producing county, the Dolcoath main lode being 2¼ miles in length. But whereas Cornwall produced 4,700 tons of tin in 1901, the Malay Peninsula produced in the same year no less than 50,352 tons.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

ROYAL METEOROLOGICAL SOCIETY.—The Council of this Society have this Session introduced an innovation by arranging for a meeting to be held out of London, with the view of stimulating interest in meteorological matters among the Fellows and others resident in some provincial centre. Manchester was selected for the first meeting, and this was held on February 23, in the Physical Laboratory of the Manchaster University, the President, Mr. H. Mellish, being in the chair.

Mr. A. Hopkinson, K.C., the Vice-Chancellor, expressed on behalf of the University the special gratification which they felt in welcoming the Fellows of the Society, the nature of whose work appealed to everyone. He said that the history of the University showed that they were ready to take a part not merely in word, but by act, in this branch of scientific work. Much had been accomplished in meteorology by the work that had been initiated and so liberally supported by Dr. Schuster.

Dr. A. Schuster also welcomed the Society, and said that meteorology in itself might be only a small part of physics, but it was intimately connected with a number of other subjects, especially with one large subject which, he thought, had received far too little attention in the Universities, namely, the physics of the globe. By this he meant the physics not only of the movements of the atmosphere, but of the atmosphere generally, its composition, its electrical phenonema, its effects on terrestrial magnetism, and its connection with the things that are happening on and under the surface of the earth. All these things hung together intimately, and ought to be considered generally as one subject of geophysics.

The first paper read was on the "Investigation of the Electrical State of the Upper Atmosphere made at the Howard Estate Observatory, Glossop," by Dr. W. Makower, Mr. A. J. Makower, and Miss Margaret White. The second paper was on the "Results of 25 Registering Balloon Ascents made from Manchester on June 2-3, 1909," by Mr. W. A. Harwood. An interesting discussion followed the reading of these papers. Messrs. R. G. K. Lempfert and R. Corless also read a joint paper on "Line Squalls and Associated Phenomena."

CLIMATIC INFLUENCES IN EGYPT AND THE SUDAN.—At the meeting of the Royal Meteorological Society on March 16, Capt. H. G. Lyons, F.R.S., delivered an interesting lecture on the "Climatic Influences in Egypt and the Sudan." He pointed out that from early times the Ancient Greeks recognised the marked difference between the climate of the Mediterranean and that of Africa, and Aristotle indicated correctly the rains of Ethiopia as the cause of the annual flood of the Nile. Travellers have supplemented our knowledge from time to time, but only within the last ten years has a network of meteorological stations given precision to our views and furnished a basis for further investigations. The comparatively low relief of the country, which lies as a vast land area in low latitudes, combined with the effect of the North-easterly Trade winds which sweep over it, produce the hot and dry conditions which are so characteristic of north-eastern Africa. Modified somewhat in the north by the warm waters of the Mediterranean, and in the south by the rains of the monsoon in summer, the highest temperatures and most arid conditions are reached between Wadi Halfa and Dongola, where Northerly winds, clear skies, and a great range of temperature prevail throughout the year.

The important rains are those falling in Uganda, the southern plains of the Sudan, and on the table land of Abyssinia, since they not only provide the whole supply of the Nile and its tributaries, but largely control their regimen. Fed by the South-easterly air-currents blowing in from the Indian Ocean, these monsoon rains supply the equatorial lakes, and the tributaries of the Nile.

But it is the Abyssinian tableland, with its heavy summer rainfall, which is most effective, since it furnishes the whole of the Nile flood and enables the Nile to maintain itself through 1,500 miles of desert. As the sole source of the flood, the variation of these rains directly determines the abundance or deficiency of Egypt's supply, so that this climatic problem is of immense importance. Hardly less important in these days of intensive cultivation of cotton, is the study of the winter storms which occasionally break in the Sudan and Abyssinia, raising the level of the rivers and increasing the supply of the Nile appreciably at a time when the normal supply is inadequate. The climate of the region not only influences the water supply, but the great range of temperature rapidly disintegrates the rocks and the wind removes the finer portion of the material. In this way the deserts are being constantly modified, and vast ranges of sand dunes are piled up. The distribution of vegetation is very markedly influenced both by the moisture and by the physical character of the country.

REGISTERING-BALLOON ASCENTS, DECEMBER, 1909.—A number of registering-balloon ascents were made in this country in connection with the ascents organised by the

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International Commission for Scientific Aeronautics during the period December 6 to 11, 1909. The stations from which the balloons were sent up were: Dhulough, Co. Galway; Crinan, on the west coast of Scotland; Manchester; Pyrton Hill, near Watlington, Oxon.; and Ditcham Park, near Petersfield. The tabulations from the 17 meteorographs which have been recovered have been printed in a special supplement to the "Weekly Weather Report."

The following table shows the directions the balloons took and the distance they travelled:

Date.	Station.	Time.	Direction.	Distance. Miles.
Dec. 6	Pyrton ..	7. 5 a.m.	S.E. by E.	36
,,	Crinan ..	8.10 ,,	N. by E.	22
,, 7	Pyrton ..	7. 0 ,,	E	53
,,	Ditcham ..	7. 6 ,,	E. by N.	79
,,	Manchester ..	7 14 ,,	E.S.E.	25
,,	Pyrton ..	3.10 p.m.	S E.	29
,,	Manchester ..	6. 0 ,,	S.E.	75
,, 8	Manchester ..	7.43 a.m.	S.E. by S.	87
,,	Crinan ..	8. 9 ,,	S.E. by S.	66
,,	Manchester ..	2.55 p.m.	S.E. by S.	109
,, 9	Manchester ..	7.10 a.m.	S.S.E.	109
,,	Dhulough ..	7.40 ,,	N.E	34
,,	Crinan ..	8.17 ,,	E S.E.	70
,,	Pyrton ..	3.35 p.m.	S.S.E.	62
,, 10	Pyrton ..	3.35 ,,	E. by S.	32
,, 11	Manchester ..	7.50 a.m.	N.	50
,,	Ditcham ..	3.18 p.m.	W.	10

THE BLUENESS OF THE SKY.—In a Friday evening lecture at the Royal Institution, on the "Colours of Sea and Sky," Lord Raleigh, said with reference to the blueness of the sky, that he upheld the view that it was due to the dispersal of light by small particles. Spring's view, that it was due to the effect of chemical matter in the air acting by absorption, he thought, was disproved by the fact that the setting sun was red, not blue, though it might be that constituents of the atmosphere, such as oxygen, acted as a secondary cause. It was a question of interest what kind of particles caused the effect. The general idea was that it was dust, particles of water, etc., but Lord Raleigh thought there was no reason to doubt that for the most part the blue of the sky was due to the dispersal of light by the actual molecules of the air.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

THE DISPLAY OF THE KAGU.—The love-displays of birds are always interesting. The latest contribution to the subject is from the pen of Mr. Arthur Denman, who, in the *Avicultural Magazine* for December—which I unfortunately overlooked—describes a pose assumed by the Kagu now in the Gardens of the Zoological Society, hitherto, I believe, unrecorded. Briefly, instead of the prancing, mincing gait with uplifted crest, characteristic of the display of this bird, the body was bowed downwards and forwards, the crest being depressed and the wings widely spread, after the fashion of the Sun-Bittern (*Eurypyga*), thereby, it is to be noted, displaying the very beautiful coloration of the primaries.

Mr. Denman suggests that this form of display may be intended as a fighting challenge. This, of course, may be the case; in other words, both this and the strutting attitude are indicative of moments of strong excitation.

GREENLAND FALCONS IN IRELAND.—A number of Greenland Falcons, we regret to find, were killed in Ireland between the month of November, 1909, and February, 1910. The following records are taken from *British Birds* for March:

An immature female shot at Achill, Co. Mayo, November 29; a male and female shot on Tory Island, Co. Donegal, December 9 and 30 respectively; a female shot at Belmullet, Co. Mayo, January 20, 1910; a male shot near Greystones, Co. Wicklow, January 12, 1910; and a female shot near Tralee, Co. Kerry, in the middle of February.

The day is evidently far distant when "sportsmen" will discover an interest in living birds other than as targets.

SNOWY OWL IN IRELAND.—A female "in almost adult plumage," was shot at Belmullet, Co. Mayo, on January 4, 1910.—*British Birds* (March).

SPOONBILL IN CO. KERRY.—"A specimen in dirty and abraded plumage" was shot near Dingle, Co. Kerry, on December 22, 1909.

LITTLE AUKS IN IRELAND.—Several specimens of this species were picked up in an exhausted condition during January, 1910, in Queen's Co., Sligo, Tipperary, Mayo, and Galway.—*British Birds* (March).

BITTERN IN KENT.—Mr. J. H. Allchin writes to *British Birds* (March) recording the fact that a Bittern was killed at Newhythe, near Aylesford, on November 25, 1909. He remarks that he is pleased to say "a police prosecution followed," but the defendant, who pleaded ignorance of the identity of the bird, was let off on payment of the costs of the hearing.

GLOSSY IBIS IN NORFOLK.—In *British Birds* (March), Mr. J. H. Gurney records the fact that on December 2, 1909, a Glossy Ibis (*Plegadis falcinellus*) was shot between the River Bure and Breydon Water.

THE INTRODUCTION OF THE WILLOW GROUSE.—We have already protested against the deplorable attempt to introduce the Ryper into Scotland, and we are glad to find support in this from Mr. A. E. Shipley and the Editor of the *Field*, in the issue of March 19.

One of the reasons urged in justification of this mischievous project was that the Ryper was not subject to grouse disease, and hence our native grouse interbreeding therewith might gain new vigour. Mr. Shipley, in the issue referred to, however, points out that this hope is quite unfounded, for he found in the cœca of Ryper sent him from Norway "the most dangerous parasite of all," those which infest our own birds—*Trichostronaylus pergracilis*.

The Editor joins with us in regretting this introduction on the grounds that our own bird (*Lagopus scoticus*) is a distinct species peculiar to Great Britain. He urges that the purity of the race should not be tampered with by the introduction of an alien race; for the Willow-Grouse (*Lagopus albus*) is, of course, *not* identical, as some seem to suppose, with our British bird. But, strange though it may seem, the percentage of sportsmen who are thoroughly familiar with the life-history of the birds they shoot is not high.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

RAYS OF POSITIVE ELECTRICITY.—In the March number of the *Philosophical Magazine*, Sir J. Thomson returns to the question of positive rays of electricity. In these new experiments the induction coil is replaced by an electrostatic induction machine, in order to secure the application of voltages between the terminals constant and measurable in value. With this he has repeated all his previous results, and in particular he has repeated the experiments on the effect of the potential-difference on the velocity of the canal-strahlen and has again found that the velocity of the swiftest rays is independent of the potential difference between the electrodes. Incidentally, he finds that measurements of this difference with an electrometer and also with the use of an air-gap in parallel show that the air-gap method works quite satisfactorily provided that certain precautions are taken. For ranges from 3,000 volts to 30,000 volts (the gas pressure in the tube being changed at the same time), the maximum value of the velocity of the positive rays and the ratio e/m both remain unchanged.

The most remarkable fact is that the maximum value of the velocity thus found may be very greatly in excess of that which the particles would gain in moving down the

total voltage in the tube. The work done when a charge e moves down through the voltage V is Ve; assuming that this all appears as kinetic energy of translation ($\frac{1}{2} m v^2$) we have $Ve = \frac{1}{2} m v^2$. The value of V calculated by this formula is 20,000 volts; the actual value was sometimes as low as 3,000. This result has such important relations with the question as to how the positive rays originate that a careful search has been made for any possible source of error, but without such being traced.

The conclusion is drawn that if the energy of the canal-strahlen is derived from the cathode rays then the energy of several of the cathode rays must have been drawn upon for the production of one particle in the canal-strahlen, for the energy of each cathode ray particle cannot exceed that due to the fall of potential between the terminals of the discharge tube. Thus, unless we suppose that there is some chemical change in the molecules from which the positive rays arise, resulting in the liberation of energy, we must regard the molecule as capable of storing up the energy communicated to it by the cathode particles when they strike against it, so that the molecule has not lost the energy acquired by one collision before it comes into collision with another cathode particle. When the energy has acquired a certain critical value Sir Joseph Thomson supposes the molecule to explode, and a positively charged particle, or it may be a neutral doublet, is shot out with a velocity greater than 2 by 10^8 cms. per second.

ZOOLOGY

By R. Lydekker.

AN INTERESTING FISH.—Great interest attaches to the recent capture off the south-west coast of Ireland, at a depth of between 670 and 770 fathoms, of a single specimen of a new species of long-beaked chimæra, or king-of-the-herrings, which has been named *Rhinochimæra atlantica*, and of which a description and figure will be found in No. IV. of Irish Fisheries Scientific Investigations for 1908 (1910). This fish, which measures about five feet in total length, is a member of a genus otherwise represented by *R. pacifica*, first described on the evidence of Japanese specimens in 1905. Both these fishes differ from the ordinary blunt-headed chimæras by the production of the upper jaw into a long, spear-like beak, and the replacement of the long whip-like tail by a much shorter and deep caudal appendage; the European species differing from its Pacific relative not only by its much superior size, but likewise by the relatively shorter base of the second dorsal fin. Probably the Atlantic species is not uncommon at comparatively great depths off the Irish coast, where, however, its capture is difficult, this being borne out by five egg-purses having been secured which probably belong to the same species.

THE TUCUMAN TAPIR.—In the *Anales* of the National Museum of Buenos Aires for 1909, Dr. F Ameghino describes the skull of a young tapir from the Argentine province of Tucuman as a new species, under the name of *Tapirus speyazzinii*. The Brazilian tapir (*T. americanus*), it will be remembered, differs from the other two tropical American species by the absence of a bony partition to the nasal chamber. In this respect the Tucuman skull conforms to the Brazilian type, from which, however, it differs widely by the much shorter and relatively broader nasal bones. This appears to be a good specific character, although it would have been more satisfactory had the author figured for comparison a skull of the Brazilian tapir similar in age to the Tucuman specimen, instead of one of a full adult animal.

THE FAIRY SHRIMP.—A correspondent in *Nature* of March 10 records the occurrence in a flooded ditch at Eton of specimens of the phyllopod crustacean commonly known as the fairy shrimp (*Chirocephalus*, or *Branchippus, diaphanus*), in which the males are green and the females brownish purple; the length being about one and a half inches in the case of the males. For many years no instance of the occurrence of this crustacean in England was noted, but specimens were recorded from Surrey in 1905, and a few years ago a couple of examples were sent to me, although I have forgotten the locality. This species only occurs in the southern counties, to which its eggs are probably transported from the Continent adhering to the feet of birds. Some of the Eton specimens were exhibited alive at a meeting of the Zoological Society.

THE UGANDA POTTO.—Till recently that remarkable group of lemur-like creatures typified by Bosman's potto was, like many other African forest animals, supposed to be confined to the west coast. A few years ago, however, Sir H. H. Johnston announced that he had evidence of the existence of pottos in Uganda, although the specimen on which the announcement rested was unfortunately lost. A skin recently received at the British Museum fully confirms the accuracy of the original statement, and likewise indicates that the Uganda potto represents a perfectly distinct species, for which the name *Perodicticus ibeanus* has been suggested.

PAPERS READ.—At the meeting of the Zoological Society of London, held on March 1, Dr. C. W. Andrews exhibited teeth of fossil elephants from later Tertiary deposits in Sze-Chuen, N.W. China, remarkable for their extremely recent-looking appearance. They were referred to the species known as *Elephas insignis*, which is typically from the Siwalik Hills of Northern India, and serves to connect modern elephants with the extinct mastodons. The difference in the physical condition of the Sze-Chuen and Siwalik teeth is very striking. After this Dr. R. T. Leiper exhibited specimens of the larval stage of *Trichostrongylus pergracilis*, the active agent in grouse-disease. It has been found experimentally that the development is almost exactly the same as that of the ankylostome—the cause of miner's disease in Cornwall. The egg develops into embryos in about two days, which metamorphose on the eighth day into an active larva that climbs heather in wet weather. These larvæ were found in numbers on plants of which the roots were artificially infected. Subsequent drying does not kill the larvæ, as by encysting they can survive several weeks, although unable to resist desiccation. They undergo no further developmental change, and when given to healthy grouse produce infection; eggs being found within four days in the droppings. The papers included one by Sir G. F. Hampson on African moths, and an account, by Mr. T. H. Burlend, of certain organs of the chimæra. The papers down for reading on March 15 comprised notes on the skeleton of the shark *Chlamydo-selache*, by Mr. T. Goodey; local variation in sea-elephants, by Dr. Einar Lönnberg; and observations on the alimentary tract of birds, by Mr. Beddard.

REVIEWS OF BOOKS.

ASTRONOMY.

Curiosities of the Sky, by Garrett P. Serviss (New York and London: Harper and Brothers, 1909; pp. xvii. and 268; 6s. net).—Presented in a distinctly conversational style, without any attempt at the usual text-book routine, this very interesting volume will appeal to readers desiring a general description of the main features of the starry firmament. Beginning with the Milky Way and an account of the wonderful gaps in it—the Coal Sacks, for instance—we are led to think out possible explanations of the galactic cosmos. The difficulty of believing that regularly-shaped openings could be formed in an irregularly distributed group of stars leads to the idea of *dark nebulæ* shutting out light from the area they cover; a good example of this occurs in the region photographed by Barnard near ρ *Ophiuchi*. The Galaxy is then more particularly studied regarding the star clusters, streams, and star clouds which undoubtedly appear to be connected with it. It is interesting to note that the prevalence of variable stars of short period in star-clusters is discussed in connection with the possibility of this variation being due to collisions between masses of the material composing the bodies. The dual star drift, which has been better understood of recent years, is also clearly described in simple language. In discussing proper motions and their results the author gives some fascinating forecasts of the forms eventually to be assumed by several of our

familiar constellations. Passing on to objects indicating cosmical change, the reader is introduced to the phenomena attending the life of a *new* star. Possibly here the author lays too much stress on the similarity to a conflagration; the chief argument appears to be the case of Nova Persei, especially the increasing ruddiness during the period of decay. This view must not be pushed too far, as it is not impossible that the appearance may be due to the increase of absorbing vapours, and not to decrease of temperature consequent on the closing stages of a great conflagration. The chapter on whirling nebulæ is very vividly descriptive; we cannot agree, however, with the author's interpretation of the photographic structure of the Andromeda nebula not being decidedly spiral, and that they look as much like circles as ellipses. If the whirls be traced separately they can be followed from their points of origin in the central mass, and it can clearly be seen that they do not return on themselves. In the pages dealing with the chief solar phenomena the theories of Arrhenius are given a foremost place, and this is also the case with the phenomena of the zodaical light and comets. This theory of light pressure repulsion is cited as supporting Bredechin's theory of comets' tails, but it should be noted that in the last two notable comets, Daniel and Morehouse, the straight tails have shown no evidence of the presence of hydrogen, as required by the hypothesis. The book concludes with a review of the recent discussions about the physical characteristics of the planet Mars; regarding the canals, however, the evidence of the best observers during the last opposition still leaves the question undecided, and as regards the presence of water vapour the powerful opinion resulting from the Lick expedition to Mount Whitney is definitely against the probability of the atmosphere of Mars containing appreciably more water vapour than is present on the moon. The book is well supplied with illustrations, which are excellently reproduced. It is to be regretted that they are not provided with orientation letters, and we should also prefer to see the authorship of all illustrations cited. In one or two cases the beautiful lunar photographs obtained by Ritchey are referred to particularly, but otherwise the source of the photographs is left uncertain.

BOTANY.

British Wild Flowers, in their Natural Colours and Forms, by the Rev. Professor Henslow, M.A. (S.P.C.K.; 8s.).—The scope of this book is outlined in the preface as being "in no sense one on botany, in the ordinary meaning of the term; we have not described the species mentioned, but have given instead the curious ways by which insects pollinate flowers; as such may lead the reader to make his or her own observations. This is the only way to study Nature." The lack of descriptions of the plants mentioned is more than compensated for by the presence of over 200 beautifully drawn and coloured figures of the plants dealt with. The text is written in the well-known easy and lucid style of the author, and if carefully studied will result in the accumulation of a considerable insight as to the why and wherefore of such diversity of structure, form, colour, etc., as presented by our wild flowers. The book is admirably adapted to the large class of Nature-loving students desirous of learning something respecting our wild plants other than the technical and systematic side, while at the same time the knowledge of the systematic student will be broadened by its perusal.

Flowers of the Field, by C. A. Johns, Edited by Prof. G. S. Boulger, F.L.S., F.G.S. (Society for Promoting Christian Knowledge; 32nd edition, with 64 coloured plates; pp. 926 with index; 7s. 6d.).—There seems to be a perennial demand for this work, and we are glad to see another edition, edited, as it is, by Professor Boulger, than whom we can have no safer guide. The coloured illustrations are well executed, and give additional value to the issue. It is particularly welcome at this time of the year, and the army of field-path ramblers who are cleaning up their vascula in readiness for their country walks cannot do better than take this edition of Johns as their guide and friend.

CHEMISTRY.

Recent Advances in Physical and Inorganic Chemistry, by A. W. Stewart, D.Sc. (London: Longmans and Co.; pp. xi. and 267; 7s. 6d. net).—This book is a worthy companion to the same author's "Recent Advances in Organic Chemistry," and is based upon similar lines. Like the former work, it aims both at giving a clear outline of the present-day state of our knowledge in various branches of physical and inorganic chemistry and also at indicating directions in which research is likely to lead to fruitful results in future; and we have no hesitation in stating that in both aims it has been successful. Even a reader with only a slight acquaintance with chemistry will be able to follow the excellent series of essays in which Dr. Stewart summarises the modern views upon such subjects as colloids, the problem of oceanic deposits, radio-active elements, absorption spectra, etc. In each case where there is a conflict of opinion, the views on both sides are fairly stated, and in doing this the author has managed to avoid the pitfall of giving merely a succession of colourless abstracts. The book opens with a brief but interesting introduction by Sir William Ramsay, and concludes with an excellent subject index and an index of names, both of which increase the utility of the book to the student of chemistry.

History of Chemistry, by Sir E. Thorpe, F.R.S. (London: Watts and Co.; pp. viii. and 148; 1s. net).—In this little book Sir Edward Thorpe again shows his gift of interesting the reader in what we may term the "humanities" of chemistry. Although the size of the book has necessitated the compression of a historical survey into a small compass the story never degenerates into a catalogue of facts, but holds the interest of the reader to the last page. Starting from the Chemistry of the Ancients, the reader is taken successively through the period of alchemy and the search for the Philosopher's Stone to the beginnings of scientific chemistry, and then onwards to the time of the atomic theory and the beginning of physical chemistry in the 19th Century. Thoroughly readable outlines are given of the views held at each period and the story is rendered still more interesting by biographical sketches of the men whose names are mentioned. The book is also illustrated with excellent reproductions of prints and pictures of great chemists of the past, and is clearly printed. It is in every respect a marvel of cheapness. We look forward to the appearance of the second part, which will continue the story from the middle of the 19th Century down to the present day.

GEOLOGY.

Geological and Archæological Notes on Orangia. by J. P. Johnson (Longmans, Green and Co.; pp. 102, with index, illustrated; small 4to; 10s.).—This book serves as a useful guide and summary. Dealing first with the stratigraphy of the colony, it passes to a description of the Kimberlite dykes and pipes, the volcanic diamond-bearing rock of South Africa. The flat and level-bottomed "pans" and "vleis" are discussed. Pans are always bounded on one side by a dyke, and farmers' wells are always situated at the junction of a pan with a dyke. A vlei holds water for an hour or two after rain, and would become enlarged into a pan by the trampling of vast herds of game which formerly came to slake their thirst. On drying up the pulverised shale is disintegrated into dust and the wind aids in clearing out the pan. We would suggest that the fact that they held water at all may have been through the puddling brought about by cattle, and the farmers would do well to store their limited rainfall by repeating the process. The author emphasises repeatedly the greater rainfall which the country formerly possessed. He has collected much evidence of former stone-implement-using races and figures many Acheulian and Solutrean types. Aboriginal rock-"peckings" and paintings on the rocks appear to be numerous, and are well illustrated in the book. These consist of representations of various wild animals as well as of human beings, some of the latter being remarkable for the development of the muscles of the legs and of the hind quarters. Altogether, we have a valuable contribution to the geological and archæological literature of South Africa.

Aids in Practical Geology, by Grenville A. J. Cole, M.R.I.A., F.G.S., sixth edition, with numerous illustrations (London: C. Griffin and Co.; pp. 430, including index; 10s. 6d.).—Professor Grenville Cole's writings are always welcome, and many a young geologist

has reason to thank him for the entertaining manner in which he has taught them their first steps in geology. The present edition of these "Aids" will receive a similar welcome. The book covers a wide area. A large section is devoted to the rocks and minerals of the earth's crust, their examination by various tests, and descriptions of their physical features. Fossils are dealt with by giving descriptions of certain generic types, and tracing them and their allied forms through the geological sequence of strata. There are certain disadvantages in this method, but they are to a great extent removed by a useful list of characteristic invertebrate fossils, under the heading of each of the geological systems and formations. We will only add that Prof. Cole's book is worthy of better illustrations, especially of the fossils.

NATURAL HISTORY.

The Naturalist on the River Amazon. by H. W. Bates, F.R.S. (John Murray; pp. 394; 8vo.; 1s. net).—This well-known classic forms one of Murray's new shilling series, which also includes Dean Stanley's **Sinai and Palestine,** and Smiles' **Self Help.** Bates' work will always appeal to Nature-lovers who prefer the narrative style and who shun the more methodical text-book. Such a work has often been the means of making a naturalist, where previously a bent for Nature has been latent. Bates left England in 1848, in company with Mr. Wallace, and he returned in 1859, and in his book we have a monument of the great work which he accomplished during eleven of the best years of his life. The book is well bound in cloth, and, of course, has a good index. It has a number of illustrations and one cannot want a better edition.

PHYSICS.

Electricity, by H. M. Hobart, B.Sc., M.I.C.E. (London: Constable and Co., 1909; 6s. net).—Our author is dissatisfied with current text-books concerning electricity and he consequently writes another in which most things, when defined at all, are defined differently from usual. It appears that an engineer may be expected to understand things better if electricity is taken as measured by its energy—because that is what we pay 3d. a unit for. When we turn to see how a *current* is defined we find no definition at all; but it is stated to be the ratio of "pressure" (whatever that is) to "resistance" (whatever that may be). As far as we can judge, a current is intended to be the old-fashioned electrical current that we are all familiar with, and not the *rate of flow of energy* as we hoped to find it defined. We are quite in favour of simplifying the statements and conceptions of the professional physicist to suit engineering students; but we must say quite frankly that it would be a bad day for the science of electrical engineering if a student received no more logical presentation of his subject than what he is given here. We feel sure that Mr. Hobart must, after all, suppose that the student has learned his electricity in another way and that he merely intends here to pick out some salient facts which will be of use to him in his engineering practice. Looked at from this point of view we add that the information conveyed by the numerous well-drawn curves of data will be found to be of great value.

First Stage Sound, Light, and Heat (Organised Science Series), by R. W. Stewart, D.Sc. Second edition, revised and rewritten (London: University Tutorial Press, 1909: 2s.).—A course of carefully selected experiments has been made the basis of this new edition in order to meet the requirements of teaching in schools to-day. The book on the whole is very lucid. The final formulæ given for mirrors and lenses do not seem to be the happiest; nor do we feel clear that a pupil will know how to apply them in every case. A few statements are unnecessarily loose, *e.g.*, to say that the temperature of a freezing mixture of ice and salt *is* --22° C. without stating the proportions is scarcely sufficient. But the book is to be commended on the whole.

ZOOLOGY.

The Mammals of Somaliland, by R. E. Drake-Brockman (London: Hurst and Blackett, 1910; pp. xvii. and 201, illustrated: 12s. 6d. net).—As an official resident in the country, Mr. Drake-Brockman enjoys unrivalled opportunities of studying the Somali fauna, and, so far at least as mammals are concerned, appears to have taken full advantage of his position. The present well-illustrated volume is indeed a thoroughly scientific, and in no sense a sporting, account of the animals of the country; and one well worthy to rank with Mr. W. L. Sclater's "Mammals of South Africa." No new species or races are actually described in this volume, although it includes mention of a race of Philipps's dik-dik antelope from the Guban district to which the author gave a special name last year. In failing to recognise the racial distinctness of the Somali and East African big-eared fox, Mr. Brockman has given American naturalists an opportunity of which they have not been slow to make the most. The illustrations are for the most part reproductions from photographs of living or freshly-killed animals; and, in the case of the former at any rate, are worthy of all commendation. I may specially refer to the portrait of that beautiful antelope, the lesser kudu, which is a characteristic species of Somaliland and Upper East Africa. The Somali fauna is of special interest as making the northern limit, or approximately so, of a number of southern types, which extend thus far by way of the open country of East Africa. Among such southern forms are the aforesaid big-eared fox, the hunting-dog, the aard-wolf, and the ant-bear. Northern types, on the other hand, are represented by the striped hyæna, the dik-dik antelopes, and various members of the gazelle group, all of which extend a considerable distance into East Africa proper. On the other hand, Somaliland has many peculiar types of its own, in some cases confined to the country, but in other instances ranging a greater or smaller distance into East Africa. Among such, may be mentioned Swayne's hartebeest, Clarke's and Waller's gazelles, Grévy's zebra, and above all the weird little naked sand-rats, which make tunnels in the sand of the coldest part of the country. In correlation with the general barren nature of the country, is the paucity of monkeys, of which only two species are recorded. Mr. Brockman is to be congratulated on this latest contribution to our knowledge of the African fauna.

MISCELLANEOUS.

Across Papua, by Colonel Kenneth Mackay (Witherby and Co.; pp. xvi. and 192, including index; 41 illustrations from photographs, and map of author's route; 7s. 6d. net).—This work gives a description of the journeys of the author, as chairman of a Royal Commission of enquiry into the conditions of government, etc., in British New Guinea. It appears that Australia desired to annex Papua in 1883, but the Home Government failed to see the necessity of it. A portion of the island was made a British Protectorate in 1884, but the greater portion has passed into the hands of another European Power. The author has not, he says, "touched on the real work of the Commission—that will be found in the official report." The result is that although what he has to say is interesting, there is little that is really of value in the book, although there is quite enough to show that many discomforts had to be borne and dangers passed through by the party in pursuit of their enquiry. We think the British public deserved to have had something more substantial given to them, even though it had also to appear in the official report.

Air and Health, by Ronald G. Macfie, M.A. (London: Methuen and Co.; pp. 345, including index; 7s. 6d. net).—This is a most valuable work. The title adequately describes the contents. The atmosphere, its composition, and its bearing on respiration, are discussed in a masterly manner. Air-pressure, temperature, and humidity are dealt with in their relation to health. Pollution of air and its causes, ventilation, draughts and "colds," how to breathe properly, and the open-air treatment of consumption, are a few more of the excellent chapters we find before us. The marshalling of facts and statistics is done in a manner to command attention, and science is drawn upon in all directions in order to shed light on the subject of the relation between the air we have to breathe and our bodily hygiene.

XUM

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

The Microscope and Modern Medicine.

WE are all of us more or less aware of the vast advances made by modern medicine in common with all other sciences, and the great gospel of asepsis preached by Lord Lister has so revolutionised modern surgery and extended the field of operation that we are apt to look upon the surgeon—as apart from the physician—as bearing off the honours of the day. None the less, the most notable advances have unquestionably been made in the domain of the physician, and especially in those of preventive medicine. A recent presidential address by Professor E. A. Minchin to the members of the Quekett Club, entitled "Some Applications of Microscopy to Modern Science and Practical Knowledge," has suggested to me that it may be of interest if I endeavour to show how much the advance in the art of medicine, alluded to above, owes to the modern microscope and to improved methods of laboratory technique connected with its use.

In histology and pathology the microscope is manifestly indispensable. The highly organised and specialised tissues of the human body tax our best powers of microscopic observation, and the structure of the individual cell, its mode of sub-division and growth, attract a large number of workers. Volumes, too, have been written about the blood, about the nature and appearance of the corpuscles in it, their minute differences, and their behaviour in health and disease. From the point of view of popular science alone, an interesting chapter could be written on the part played (as far as we know it) by those white blood corpuscles, so much fewer than the red corpuscles which give the blood its colour (about one in six hundred), in health, and more especially in disease, of their strange amœboid movements, of their accumulation upon the scene of any injury or inflammation of the tissues, of their protective nature, of their power to ingest bacteria, and of other attributes too technical to detail in a single sentence. It will be readily understood, however, that the study of the blood by means of the microscope forms an important part of the work, not only of the laboratory research man, but of the physician in his work.

One is tempted to enlarge upon the great modern science of bacteriology and its bearing upon disease, but there can be few educated men and women who are ignorant of the fact that diseases such as tuberculosis, typhoid fever, cholera, diphtheria, tetanus, plague, pneumonia, and leprosy are all due to different forms of bacteria, distinct and recognisable from each other, capable of being cultivated on suitable nutritive media, and, when inoculated, of giving the original disease to men or animals. There can be little doubt that sooner or later all other infective diseases from which we suffer will be shown to be due to some living organism, bacterial or otherwise, though hitherto some of the commonest diseases, such as measles, chicken-pox, scarlet fever, and mumps, have eluded the skill of the most patient investigators. But enormous possibilities of alleviation for the human race have been opened out by the comparatively recently developed methods of producing what is known as "immunity," or comparative non-susceptibility to a particular disease or organism. We all know that certain persons are practically immune to certain diseases, having a natural immunity, and that such immunity may be acquired, as in the comparative immunity to small-pox acquired by those who have already suffered from the disease or who have been vaccinated. Of the exact nature of this immunity there is still controversy, but it is in the second case unquestionably due to bacterial products introduced into the system. Bacteriologists speak of an "active" and a "passive" immunity, or of an immunity obtained directly or indirectly. For instance, in active or direct immunity the living bacteria may be cultivated, and by growing them in the presence of oxygen, or by passing them through another animal of a different species, or by growing them at unusual temperatures, or in the presence of weak antiseptics, they may become so attenuated as to lose much of their original power, and so injected; or dead organisms may be injected; or cultures may be injected which contain merely toxic products, but from which the bacteria have been filtered out, small doses being given at first and increasing doses given later as the subject becomes more and more used to them. These methods have been applied to give protection against such diseases as small-pox, anthrax, cholera, typhoid fever, and hydrophobia.

In passive or indirect immunity a different and even more interesting method is made use of. It is found that if an animal be made immune by one of these methods the serum of its blood may confer immunity upon another animal, and so may have not merely a preventive but even a curative effect. Such a serum is known as an anti-toxic serum or an anti-bacterial serum, according to whether it neutralises a poisonous product of certain bacteria or the living and harmful bacteria themselves. By this means so dreaded a disease as diphtheria has been robbed of more than half its mortality, and sera of known therapeutic value can be obtained by medical practitioners and are in general use for the treatment of this disease, and of other terrible diseases such as tetanus.

It is needless to insist upon the part the microscope has played in the investigation of all these bacterial diseases, and how the above important developments, with their performance of the present day, and still greater promise for the future, have followed in natural sequence.

But even more interesting are recent investigations into what are generally known as "tropical diseases," more especially malaria, kala azar or "black-sickness," "Oriental sore" or "Delhi boil," tsetse-fly disease, sleeping-sickness, relapsing fever, Malta fever, plague, and yellow fever. The stories of the various discoveries in connection with the etiology of these diseases read more like fairy tales than the sober matters of scientific fact that they really are, and for this reason are worth dealing with in a little more detail.

Malaria is a disease mention of which is found in the oldest medical writings, and the prevalent opinion as to its cause is shown in its name "mal'aria," or bad air. References to this idea are found in English literature, two examples which will occur to the reader being found in Charles Dickens' description of the sufferings of the settlers in "Eden" in "Martin Chuzzlewit," and in Stanley Weyman's "Gentleman of France," where great stress is laid upon the heavy mists overhanging the plague-infested valley, though apparently the author deals here with bubonic plague rather than malaria. It seems only the other day since travellers crossing the Roman

Campagna were invariably warned by the drivers of the carriages to pull up the glass windows so as not to breathe the poisonous exhalations of the low-lying ground. A copy of Baedeker's Central Italy, dated 1879, upon my library shelves, speaks of the malaria of the Campagna as being produced by "defective drainage and the evaporation of stagnant water." But whatever might be former erroneous opinions as to the etiology of malaria, as far back as 1640 it was known that in cinchona bark we had a specific drug for treating the disease, and its wider introduction into Europe from South America by Jesuit missionaries caused it to be known as "Jesuit's Bark." A remarkable forecast of the truth was made by Rasori (1762-1827) when he says: "For many years I have held the opinion that the intermittent fevers are produced by parasites which call forth a new paroxysm by the act of their reproduction which occurs at more or less rapid intervals according to the species." But in 1879-99 Professor Ronald Ross and the Italian School proved beyond doubt that the disease was due to a lowly organism known as the *Plasmodium malariæ*, which passed part of its life-cycle in man as intermediate host and part in a certain species of mosquito as definitive host, the parasite undergoing certain developmental changes when in the human blood, which are completed in cycles of 48 hours and so produce what is known as the "tertian" type of fever, or of 72 hours producing the "quartan" type; or that there may be a double infection of the tertian type to produce the "quotidian" type of fever. To transmit malaria there must exist an infected patient and the mosquito to suck the blood of the patient and so to transmit the plasmodium to another victim. The proofs of all this are too long to be detailed here, but they include the isolation of the plasmodium in malaria patients and in mosquitoes fed upon their blood, and the tracing of its development. Perhaps the most dramatic piece of evidence is that in which Manson fed mosquitoes on the blood of patients in Italy suffering from mild tertian fever, took the insects to London, and allowed them to bite his own son, Dr. Thurburn Manson, who, with a devotion to the cause of science less rare than would be credited, offered himself for the purpose. In due course Dr. Thurburn Manson developed an attack of tertian fever, and the parasites were found in his blood. It has been shown, too, that men can live safely in malaria-infested districts provided a rigid protection of mosquito nets (especially at sundown) is afforded them.

Fortunately it has been found that the transmission of the disease is limited to a genus of mosquito known as *anopheles*, that this mosquito is only found in certain districts, that its breeding places are in tanks and stagnant pools, and that when such tanks are emptied, and the pools either drained or the larvæ killed by the sprinkling of petroleum, and these measures can be and are carried out with thoroughness so as to rid the district of *anopheles*, then a marked lowering of the number of cases or even a complete local extirpation of the disease will assuredly follow.

Not less striking are the investigations into the cause and control of yellow fever, that curse of the West Indies and South America, with its constant menace to sea-ports and countries in communication with these districts. The parasite in this case has not yet been definitely determined, but it is established beyond reasonable doubt that here also transmission takes place through the bite of a mosquito, *Stegomyia fasciata*, and that bedding and clothing from patients are non-infective. Even intercourse with the sick *per se* has been proved to be free from danger; it is the sick-room, because it harbours the stegomyia, that is dangerous, and the room is infectious only as long as the life of the infected mosquito, which may extend unfortunately from 70 to 100 or even more days. It is this mode of attack which renders ships lying in rivers' mouths and sea-ports, where the mosquito in a suitable climate can live and thrive, so peculiarly liable to infection. The mosquito itself does not become infectious until from a week to a fortnight after sucking the blood of a patient, and it is noteworthy that the blood of the patient, taken between the first and third day of the disease, can itself transmit the disease by inoculation. On the other hand it seems unfortunately to be true that a mosquito can be congenitally infected from its parent.

Prophylaxis in yellow fever is on similar lines to that in malaria, namely, a crusade against the mosquitoes—their extermination in the house, the protection of the patient by mosquito nets, and the covering up or destruction of the tanks and pools in which the mosquito breeds. Burning sulphur kills mosquitoes, though, of course, it is harmless to bacteria, and houses are thus readily disinfected after yellow fever. It is interesting to note that by the adoption of these means the disease has been practically stamped out in Havana, that great hot-bed of the scourge, whence it spread to far-distant ports; and Havana itself has within quite recent years been in a position to declare a state of quarantine against other ports like New Orleans!

Another and not less interesting development of modern medicine, in which the microscope has played a prominent part, is plague, that terrible disease of which we have record three centuries before Christ, and again in the great plague of Justinian in 542 A.D. The Venerable Bede, venerable in learning rather than in years, writing in his cell at Jarrow-on-Tyne, records the great epidemic at the end of the seventh century, and in 1346-47, in 1361, and in 1368 appeared those terrible visitations of the "Black Death" which, spreading over the whole of Europe, including England, have been dealt with so often by historians, and by which it has been computed no less than twenty-five million persons, or one-fourth of the population of Europe, lost their lives. Epidemics followed in the fifteenth, sixteenth, and seventeenth centuries, and in England culminated in the Great Plague of London in 1665, in which about 70,000 victims died, and which was only terminated by the ordeal of the Great Fire of London. Soon after this the disease vanished altogether from England and did not recur again until the purely localised outbreak of 1900 in Glasgow, when only 30 persons were affected owing to prompt preventive measures. In Eastern Europe, in India, in China, and in other Eastern countries the disease has given rise to numerous outbreaks within quite recent times. The recent epidemics in Hong Kong, with its filthy social conditions, its incredible overcrowding, its great warehouses swarming with rats, and its enormous potentialities of danger by transmission to almost all the ports of the world, have been notable in that it was in Hong Kong that the *Bacillus pestis* was first discovered, and the observation was made that before the outbreak amongst men, rats had been dying in large numbers. Much work has been since done on the bacillus and more than one valuable life has been lost in the necessary laboratory investigations, the accidental breakage of a tube in a Vienna laboratory causing many deaths. There can be no doubt as to the part played by rats in the transmission of the disease, these animals being common on ships and being themselves peculiarly susceptible. But the most interesting part of the latest discovery is that the common mode of transmission from rat to rat, and from rat to man, is by

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means of fleas infesting rats, and in particular by the common Indian rat-flea *Pulex cheopis*. Experiments have shown that over 50 per cent. of healthy rats, living in flea-proof cages, contracted plague after receiving fleas collected from rats dying from plague in other cages, and that when fleas were excluded the healthy and the infected rat might be in the closest contact without transmission, but if fleas were present the disease spread with a rapidity depending directly on the number of fleas present. Moreover, the dissection of 77 fleas caught in infected houses showed that 23 harboured *Bacillus pestis*. Important as this means of transmission is, however, it is not the only means, there being no doubt that the bacilli may be acquired from a patient suffering from plague by means of inspired air.

Not the least interesting development in connection with plague is the active immunity that is obtained by injecting killed cultures of the bacilli into man (Haffkine's method), which unfortunately is attended by considerable febrile disturbance and localised pain, and the passive immunity conferred—though apparently to a much less extent—by utilising serum only from horses which have themselves acquired an active immunity by means of the first method.

Allusions have been frequent in newspapers to a very fatal disease of Equatorial Africa known as "Sleeping Sickness," a disease so terrible that the worst curse one native can give to another is to say "May you die of sleeping sickness!" The name not inaptly describes the main symptom of the disease, with its initial dulness, progressing to lethargy, drowsiness, insensibility, and coma, within the space of a month or six weeks. Alarm has been caused by the rapid spread and extended area of the disease, and special commissions have been sent out from England to investigate it upon the spot. No doubt now remains that the cause of the disease is a trypanosome (*Trypanosoma gambiense*), and that it is transmitted by a species of tsetse-fly, *Glossina palpalis*, though several minor points still remain unsettled. Koch has pointed out that the crocodile acts as one at any rate of the intermediate hosts, and a recent observer has shown that the trypanosome undergoes a developmental cycle of about three weeks in the tsetse-fly before it becomes communicable to man and other animals.

A disease that claims a heavy mortality amongst the natives of certain districts in India is "kala-azar" or "Dum-dum Fever," and though our knowledge here again is incomplete, evidence is now fairly conclusive that it is due to a flagellated protozoon known by the names of its discoverers as *Leishmania donovani*, though the alternative host, which analogy teaches us to look for, has not yet been found. Further patient investigation will doubtless complete our knowledge here as in other cases, recent researches pointing to the common bed-bug, *Cimex rotundatus*, as the offender in this case.

The last disease which has yielded to modern investigation by microscopical and laboratory methods is Malta or Mediterranean Fever, now known to be identical with the "Rock Fever" of Gibraltar, which has for long invalided so large a proportion of British troops quartered in these garrisons, and which infests the neighbouring shores. Here again patient investigation has shown the disease to be caused by a microbe, *Micrococcus melitensis*, and evidence is strong that the intermediate hosts are the goats which supply the bulk of the milk consumed locally.

One can only mention in passing diseases like Relapsing Fever, which is due to a spirochæte (*Spirochæta obermeieri*), and in connection with which the body-louse is suspected, and Tick Fever, due to another spirochæte (*Spirochæta duttoni*), in which the bite of the African tick, *Ornithodorus moubata*, has been proved to be the indirect cause. Enough has been said to show of what nature, and how fraught with possibilities of relief from death and suffering to the human race, are some of the more recent medical discoveries in which the microscope has played a prominent part, discoveries that bring to one's mind Milton's lines to the Lord General Cromwell:

> "Yet much remains
> To conquer still; Peace hath her victories
> No less renowned than war."

Royal Microscopical Society.

February 16th, Professor J. A. Thomson, M.A., President, in the Chair. An old microscope by Trécourt and Georges Oberhaeuser, an old microscope by Browning, and eight Lieberkühn microscopes in cases were presented to the Society by the Council, and described by Mr. C. F. Rousselet. Mr. A. N. Disney also presented a Withering's Botanical Microscope, and Mr. Conrad Beck two Grayson's rulings, an inch divided into hundredths of an inch, and 25 mm. divided in 0·25 mm. Miss Fitch presented 24 micro-slides from the collection of the late Mr. Frederick Fitch, mostly insect dissections, mounted with all their internal structures displayed *in situ*.

The President thanked the Society for the honour which they had done him by electing him President. It was exactly twenty-five years ago since he began to work for the Journal of the Society, and he felt it a great honour to be added to the distinguished list of their Presidents, and, in particular, to be the immediate successor of their last President, Sir E. Ray Lankester, than whom since Huxley no zoologist had made a deeper mark on British biological science. The President then read a paper entitled "Notes on *Dendobrachia fallax*, a Rare and Divergent Antipatharian," the subject being illustrated by specimens and by a number of preparations exhibited under microscopes in the room. The difficulty of making satisfactory use of the dried specimens on account of their extreme brittleness was mentioned at the conclusion of the paper, the polyps crumbling to dust when attempts were made to cut and mount them whole. Mr. Wesché suggested a mixture of two parts of xylol to one part of phenol as a cleaning agent, which he said would clean most structures, thick or thin, and Dr. Hebb suggested the use of celloidin as imbedding agent, retaining the celloidin instead of dissolving it out, in order to hold the section together. A paper by Mr. A. A. C. E. Merlin, "On the measurement of the first nine groups of Grayson's finest twelve-band plate," was read, and a paper by Mr. F. H. Collins "On the labelling of microscopic slides." Mr. C. F. Rousselet exhibited under six microscopes four of the six known species of fresh-water Medusæ, and two of the hydroid polyps producing them, of which he gave a short account.

Messrs. C. E. Mannall Fretwell and Alfred Reid were balloted for and duly elected Fellows of the Society.

Quekett Microscopical Club.

February 22, 1910. 44th Annual General Meeting. After the usual reports had been read and passed, the annual address was delivered by the President, Professor E. A. Minchin, M.A., F.Z.S., who took for his subject "Some considerations on the Phenomena of Parasitism amongst Protozoa." Many different modes of life occur amongst Protozoa, and some of these organisms live constantly in association with some other organism, either upon it (epizoic) or in it (entozoic), neither class being necessarily parasitic. A parasite is an organism which lives at the expense of another organism, its "host."

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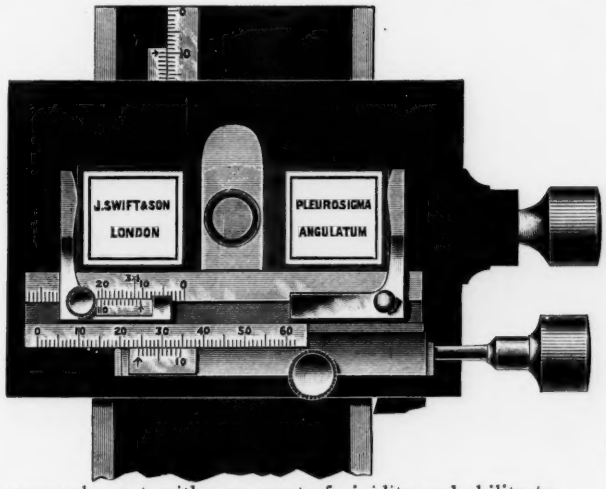
Some are extremely deadly (lethal), and others more or less harmless (non-lethal). The disease-producing powers of some parasitic Protozoa may be due partly to their powers of multiplication in the body of the host, but more probably to specific toxic effects produced by them. A consideration of the difficulties and requirements of parasitic life, and more especially of the all-important functions of their reproduction, development, and transmission from one host to another indicates clearly that it is very seldom to the best interests of a parasite to be lethal to its host. A detailed comparison of harmless and lethal trypanosomes, such as *Trypanosoma lewisi* of the rat and *T. brucii* of tsetse-fly disease, indicates that harmless parasites are forms which have long been associated with a particular host, which host has acquired powers of resistance. Parasites which are new to a particular host may be very deadly to it, since in this case the species of host has not acquired the power of adapting itself to the effects of the parasite. In the origin of new parasitic species there are, as in other organisms, two steps; first, the appearance of variations producing the disharmony seen in lethal forms; and second, the gradual establishment of normal harmonic relations by reciprocal adaptation of host and parasite.

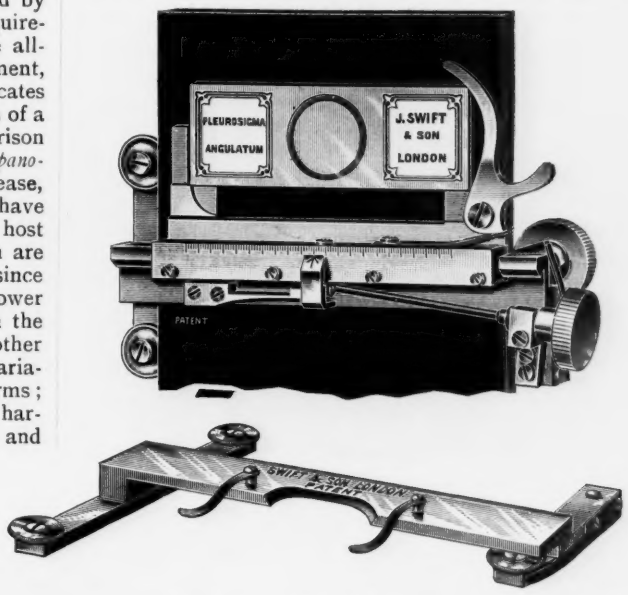
Two New Mechanical Stages.

The mechanical stage is almost a necessity in many kinds of work, and its improvement has exercised many brains. The two faults most



commonly met with are want of rigidity and ability to stand much wear (a drawback to which the removable forms are particularly liable), and want of sufficient travel (a drawback often found in the "built-in" types).

Messrs. J. Swift and Son have recently brought out two new mechanical stages, which are worth noticing in some detail. The first of these, as shown in the illustration, is of a solid yet compact form, in which the vertical movement moves the stage plate bodily by means of a diagonal rack and pinion, and has a traverse of 27 mm., reading by a vernier against a divided scale. The mechanism of the horizontal movement is removable, being attached merely by a thumbscrew, and when removed leaving a plain flat stage, to which two ordinary spring clips can be applied. The horizontal movement itself moves by means of a steel spiral, and gives a traverse of no less than 52 mm., or two inches. Both the slide clips have also independent adjustments, and one is fitted with an independent scale and vernier. When the index line of this latter is set at division 12 (marked 3 x 1), and the main horizontal scale set at 26, whilst the vertical scale stands at 15, the exact centre of an ordinary 3 x 1 inch micro-slide is found, and by moving the clips to left and right it follows that the whole of a 3 x 1 inch slide can be



systematically searched. Moreover, the clips are so fitted as to take any size slide, even broken ones, and as all three verniers read to 0·1 mm. very careful measurements and notes of position can be taken. The ingenuity and utility of the device is manifest.

The other mechanical stage, by the same makers, also permits of the examination of the whole of a 3 x 1 inch slip, and the principles of construction will be clear from the accompanying illustration. The vertical movement works by a friction-wheel in grooves in the stage, and the horizontal movement by a worm-wheel carried on a spindle set somewhat obliquely.

For those to whom the cost of a mechanical stage is a consideration the roller object clip illustrated herewith may be heartily recommended. The rollers run in grooves at the side of the stage and the bar works very smoothly. By its means a slide may be systematically searched with ease and without difficulty, and the price is very small.

Notes and Queries.

New Catalogues.—The Bausch and Lomb Optical Co. have sent me catalogues and samples of new glassware produced at their factory in Frauenwald, such as burettes, cylinders, flasks, pipettes, fermentation flasks, etc., the speciality of which is the extreme accuracy of their graduations, the lines being not only sharp and uniform, but the graduations being standardised according to the United States Bureau of Standards and the German Imperial Commission, and accompanied by a certificate of accuracy, showing errors, if any. For work of precision these graduated glass instruments are of much service, and the prices are very moderate. The same firm send me also a pamphlet describing their new projection apparatus, designed for projecting images of opaque objects on the screen, and by which, in particular, a page of a book with illustrations or letter-press can be conveniently shown to a large audience. An arrangement can be added by which the apparatus can also be used for lantern slides.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for April.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.39 and sets at 6.30; on the 30th he rises at 4.37 and sets at 7.17 The equation of time is negligible on the 15th and 16th, hence these are convenient days for the adjustment of sundials. Sun-spots have been unusually conspicuous of late; at the time of writing a group of three spots is visible. The positions of the Sun's axis, equator, and heliographic longitude of the centre of the disc are shown in the following table:—

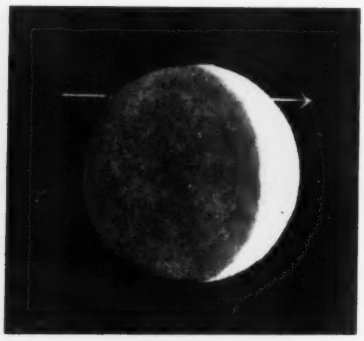
Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Apr. 1 ..	26° 19′W	6° 29′	326° 29′
,, 6 ..	26° 26′W	6° 11′	260° 31′
,, 11 ..	26° 23′W	5° 51′	194° 31′
,, 16 ..	26° 9′W	5° 28′	128° 30′
,, 21 ..	25° 43′W	5° 2′	62° 28′
,, 26 ..	25° 7′W	4° 34′	356° 24′

THE MOON:—

Date.	Phases.	H. M.
Apr. 3 ..	☾ Last Quarter	0 48 a.m.
,, 9 ..	● New Moon	9 25 p.m.
,, 16 ..	☽ First Quarter	2 4 p.m.
,, 24 ..	○ Full Moon	1 23 p.m.

OCCULTATIONS.—The following are the occultations of the brighter stars visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N point.	
			P.M.		P.M.		d. h.
Apr. 13	103 Tauri	5·5	6.53	45°	7.43	304°	3 22
,, 13	Mars	—	10.28	39°	11.4	315°	4 1
			A.M.		A.M.		
,, 16	A Geminorum	5·1	0.5	155°	0.36	227°	6 3
,, 28	26 Ophiuchi	5·8	0.35	81°	1.51	289°	18 3



Occultation of Mars, April 13.

THE PLANETS.—Mercury (April 1, R.A. $0^h\ 25^m$; Dec. N. 1° 5′. April 30, R.A. $3^h\ 48^m$; Dec. N. 22° 41′) is in superior conjunction with the Sun on the 5th, and thus at the beginning of the month is unobservable. Towards the end of the month the planet is favourably placed for observation, as he sets about 2 hours after the Sun; he is situated in Taurus, near the Pleiades.

Venus (April 1, R.A. $21^h\ 53^m$; Dec. S. 9° 56′. April 30, R.A. $23^h\ 36^m$; Dec. S. 3° 17′) is a morning star in Aquarius, rising about 3.40 a.m. near the middle of the month. The planet is a conspicuous object in the morning sky, looking S.E., and is at greatest elongation of 46° 13′ W. on the 23rd.

Mars (April 1, R.A. $4^h\ 38^m$; Dec. N. 23° 26′. April 30 R.A. $5^h\ 56^m$; Dec. N. 24° 48′) is situated in Taurus and is visible in the evenings; throughout the month he sets about midnight. The planet is diminishing in brightness, and his apparent diameter is now only 4″·8. On the 13th the planet will be occulted by the Moon as shown above.

Jupiter (April 1, R.A. $12^h\ 37^m$; Dec. S. 2° 17′. April 30, R.A. $12^h\ 25^m$; Dec. S. 1° 1′) is a brilliant object in the evening sky and visible throughout the night. The planet is admirably placed for observation, being above the horizon at sunset and on the meridian about 11 p.m. near the middle of the month. For small telescopes this is the easiest and most interesting planet to observe, on account of his brightness, attendant moons, the markings on the disc, and polar flattening. If sufficient magnifying power be used, the Great Red Spot on the belts may also be observed, and the period of rotation deduced. This is about $9^h\ 55^m$. The equatorial diameter of the planet is 43″, whilst the polar diameter is 2″·8 smaller.

The following table gives the satellite phenomena observable in this country between 7.30 p.m. and midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Apr.				Apr.				Apr.			
3	I.	Oc. D.	11 18	11	I.	Sh. I.	10 34	21	II.	Sh. E.	10 56
4	I.	Tr. I.	8 34	12	I.	Ec. R.	9 58	25	III.	Sh. E.	9 57
	I.	Sh. I.	8 40		II.	Oc. D.	10 41	26	I.	Oc. D.	10 57
	I.	Tr. E.	10 47	14	II.	Tr. E.	7 39	27	I.	Tr. I.	8 15
	I.	Sh. E.	10 55		II.	Sh. E.	8 22		I.	Sh. I.	8 52
5	I.	Ec. R.	8 4	19	I.	Oc. D.	9 12		I.	Tr. E.	10 29
	II.	Oc. D.	8 26		I.	Ec. R.	11 51		I.	Sh. E.	11 7
	II.	Ec. R.	11 21	20	I	Tr. E.	8 43	28	I.	Ec. R.	8 14
7	III.	Oc. D.	8 55		I.	Sh. E.	9 12		II.	Tr. I.	9 32
	III.	Ec. R.	11 56	21	II.	Sh. I.	8 14		II.	Sh I.	10 48
11	I.	Tr. I.	10 18		II	Tr. E.	9 55	30	II.	Ec. R.	8 28

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse and Ec. R. its reappearance.

Saturn (April 1, R.A. $1^h\ 33^m$; Dec. N. 7° 19′. April 30, R.A. $1^h\ 47^m$; Dec. N. 8° 39′) is unobservable throughout the month, being in conjunction with the sun on the 17th.

Uranus (April 15, R.A. $19^h\ 49^m$; Dec. S. 21° 36′) is visible in the mornings, rising about 2 a.m. near the middle of the month. The planet is at quadrature on the 15th, and at the stationary point on the 30th.

Neptune (April 15, R.A. $7^h\ 12^m$; Dec. N. 21° 45′) is on the meridian at 6.30 p.m., on the 1st, and sets at 2.30 a.m. The planet is situated in Gemini, about half a degree south of the star δ Geminorum.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17-May 1	16 0	+47°	τ Herculids	Small; short.
,, 20-21 ..	17 24	+36°	π Herculids	Swift; bl. white.
,, 20 22 ..	18 4	+33°	**Lyrid Shower**	Swift.
,, 30 ..	19 24	+59°	ο Draconids	Rather slow.

Algol may be observed at minimum on the 1st at 8.28 p.m. and on the 21st at 10.10 p.m. Its period is $2^d\ 20^h\ 49^m$ from which other minima may be deduced.